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Engineer or Engineman

THERE has long been more or less discussion—and just now there is a great deal—as to the meaning of the word "engineer."

At one time it probably had a definite meaning and conveyed a concrete conception. Now it means all things to all men.

One looks up John Doe in the directory and finds that he is an "engineer." It does not define John. He may be a highly educated designer and constructor of great public works or of ingenious and complex machinery, or he may be an illiterate laborer shoveling coal into a donkey engine.

He may follow any one of a hundred occupations, many of which have a remote connection with engineering as it has been until recently understood.

A bill now before Congress for the classification of the civil service enumerates twenty-one sorts of engineers in the professional class and consigns all of those of the operative type, including the men in responsible charge of the largest central and pumping stations and the power and heating plants of the largest public buildings, to the class of Skilled Laborers as "enginemen."

The engineer whose work is largely manual resents this deprivation of his ancient title, but those of them who rise to the higher positions are prone to sense the all-inclusiveness of the simpler term and become Mechanical Superintendents, Superintendents of Motive Power, Station Managers, etc.

The term engineer will mean just what common usage makes it stand for. If it includes the untaught laborer who simply attends to the physical needs of a piece of machinery, then that is what "engineer," unmodified, will mean to the ordinary man. It may mean the man who simply runs as well as the man who invents and designs and builds an engine. It may mean the man with no responsibility beyond a few manual operations or the man in charge of a big power plant. It applies equally to the man who runs a ditching machine and the man who builds a Panama Canal. This is a good deal for a single word to include.

And yet any attempt to restrict its meaning to that conveyed by Henry Gordon Stott's elaboration of Tredgold's classic definition of engineering—"The art of organizing and directing men and of controlling the forces and materials of nature for the benefit of the human race"—would be resented by the humbler members of the craft as an act of snobbishness on the part of the professionals.

There is a natural and etymological distinction. The word engineer comes from the same root as ingenuity. It suggests brains. The man whose principal accomplishment is shining brasswork would make a good janitor; the husky who shovels coal without effort but with no knowledge of what becomes of it may be an effective laborer, but the fervid eloquence of the association orator who claims for them a professional status will win no more than a quizzical smile. But the man with the engineering knowledge and practical experience necessary to operate and manage a modern power plant, the man who works with his head as well as with his hands, may well be admitted to comply with the dictionary definition of an engineer—"A person skilled in the principles and practice of any branch of engineering"—while an engineman is "A man who manages or waits on an engine."

F. R. Low

Sorocaba Hydro-Electric Plant in Brazil

Development Planned for 75,000-Hp. in Five 15,000-Hp. Turbines Operating Under a 600-Ft. Net Effective Head—Three Units Installed—Designed and Put Into Successful Operation by American Engineers

BY H. P. QUICK*

RECENT descriptions of the Paulista Railway electrification in the State of São Paulo, Brazil, appearing in various publications, make it timely to describe the power plant that furnishes the current for this initial installation and the situation that brought it about. This plant is the Sorocaba development of the São Paulo Electric Co., a subsidiary of the Brazilian Traction Co. an associate of the São Paulo Tramway Light and Power Co. The plant was first put in operation in 1914, but the war caused a lack of interest in such installations except for war purposes, and its existence has been hardly noticed. It has never been completely equipped owing to the depression in Brazil business, but now that business is better and the company has a contract to furnish 5,000 kw. to the electrified railway mentioned and as this is undoubtedly only a beginning, the additional equipment will be put in at no distant date or when exchange rates are more favorable.

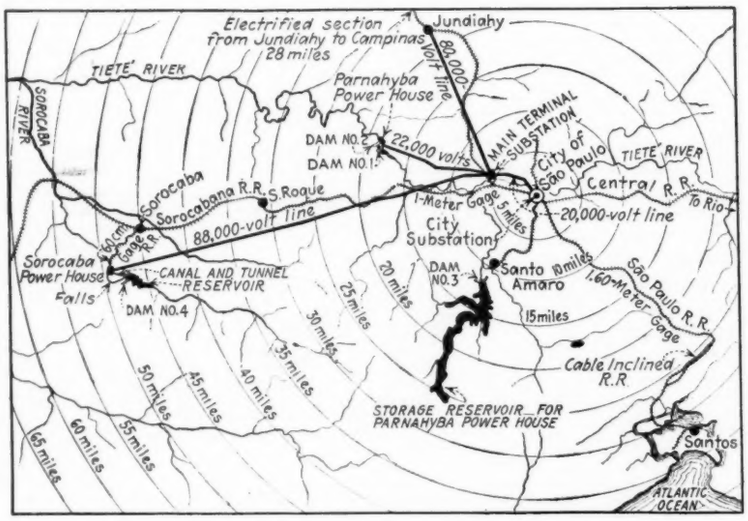

FIG. 1. MAP SHOWING LOCATION OF SOROCABA PLANT AND SURROUNDING COUNTRY

The impression has been given in some of the articles on this development that the Parnahyba hydro-electric plant, Fig. 1, the original installation of the São Paulo Tramway Light and Power Co., would furnish current to the Paulista Railway. However, while the branch of the 88,000-volt Sorocaba transmission line that has been extended to Jundiahy, the southern terminus of this railway since 1917, meets the Parnahyba line at the main terminal sub-station five miles out of the city of São Paulo, the latter is only equipped to deliver 20,000-volt current and has itself since 1914 been supplemented by power from the former. For instance, during 1917 the São Paulo Electric Co. sold the São Paulo Tramway Light and Power Co. about 60,000,000 kilowatt-hours.

The line to Jundiahy was built to supply current to some local industries and the city through a distributing company. Naturally, the presence of this power line and its connection with a modern, reliable and economical plant run and managed by experienced North Americans led to the beginning of steam-railroad electrification at this point. The electrified section extends north of Jundiahy 28 miles to Campinas.

Before going into the details of the power-plant features, it will be well to consider some of the events leading up to its inception, in a general way at least, and to describe some of the difficulties of the undertakings which American engineers overcame where other foreign nationals already on the ground had made no great headway.

It was about twenty years ago that Dr. F. S. Pearson, the noted American electrical engineer, with the aid of Canadian capital, began the work of São Paulo's electrification by building a small hydro-electric plant,

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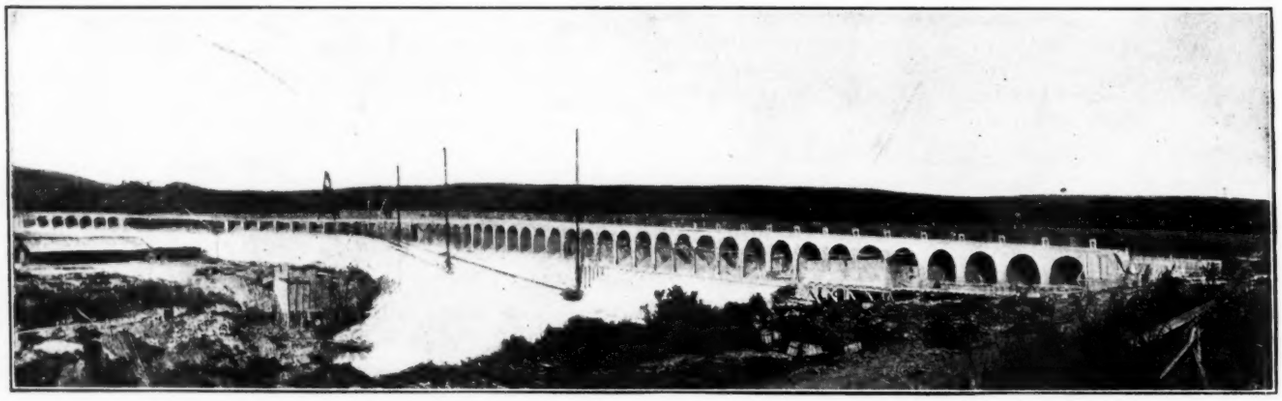

FIG. 2. STORAGE RESERVOIR OF 160,000 ACRE-FEET CAPACITY FORMED BY THIS DAM

now known as the Parnahyba plant, on the Tieté River about twenty miles below the city of São Paulo. The main purpose was to electrify the tramway system, and it was a great day for São Paulo when she emerged from the semi-darkness of previous systems of lighting and dropped the mule trams and other modes of travel more or less archaic. But the consummation of this work was not without its difficulties. The machinery and equipment all had to be imported from America and Europe some 6,000 miles away. It had to be divided into small units for convenience in transportation and to clear tunnels and bridges on the narrow-gage railways. Upon arrival at Santos it was unloaded on the docks and reloaded into the four-wheel cars of a wide-gage English railway, hauled up inclines through many tunnels, then at São Paulo transferred to the narrow-gage cars of the Sorocabana Railway and finally at a way station to oxcarts of the squeaky-axled variety for a trip over the rough country roads to the power site. This may seem a small obstacle, but it was only one of a dozen or more handicaps in handling such work. Another of these was the language. Portuguese was the common language of the country and had to be learned, although French passed with the best-educated. And because many of the better workmen were Italian or Spanish, both these languages had to receive attention.

Other difficulties were the monetary system which, especially in making estimates for local purposes and in financial statements, caused a great deal of extra work; the distance from home and headquarters, necessitating long waits for mails and much cabling in code, in fact, requiring the devising of a voluminous code book; the difference in time and time tables on railroads; the food and hours of eating, which quite changed the habits of most of our men; climatic conditions, which with prolonged tropical or semi-tropical temperatures necessitated an occasional return to the north; customs regulations, tariffs, lighterage system for the large ships, license fees, etc.; habits and customs of the people; high cost of fuel, practically all coal being imported and other fuel being scarce; troubles with animal and parasitic life, from the huge bird that short-circuits transmission lines to the tiny borer that enters lead-covered and armored cables or honeycombs wood; the metric system as compared with the English system of measurement; and the mañana habit (putting off until tomorrow).

These difficulties the men surmounted gradually, however, and the system grew by leaps and bounds, additions having to be made to the power-plant equipment and radical changes made in electrical distributing and transforming apparatus owing to unforeseen expansion year after year, until the original plant outgrew the capacity of the watershed and other sources had to be taken over.

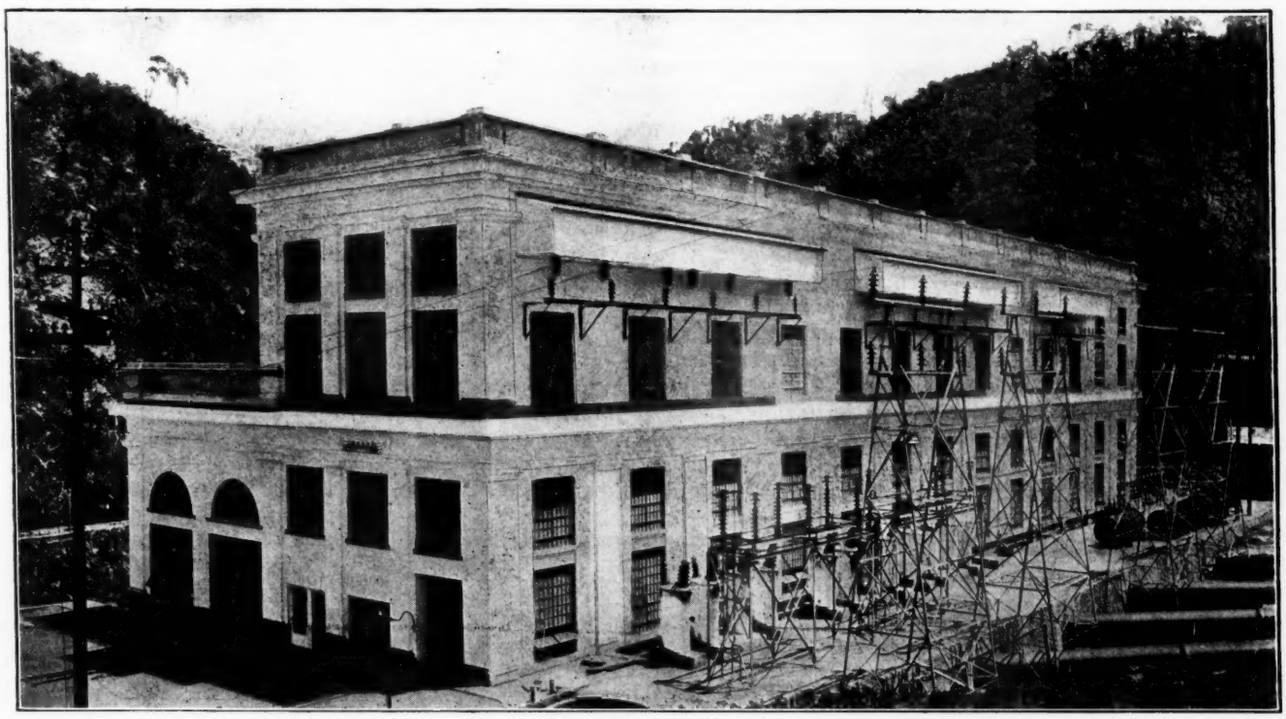

FIG. 3. POWER PLANT BUILT OF NATIVE BRICK AND COVERED WITH STUCCO

All the rivers of this region with the exception of those around Santos flow northwestward or westward from the seacoast Sierra and finally merge into the Parana, 2,000 miles in length, which goes over the great series of cataracts at La Guayra and, joining the water from the great falls of the Iquassu with those of the Paraguay and the Uruguay Rivers, forms the Rio de la Plata, which passes 75 to 100 miles wide by the doors of Buenos Aires and Montevideo.

On one of the branches of the Tieté River, the Sorocaba, some Germans had built a small plant in the years before the Americans had to consider this site, and planned greater things, but were up against the problem of a sufficient market, having only some nearby small towns in their grasp. The Pearson companies, being already established in São Paulo, relieved them of further trouble when, needing additional power, they decided on the full development of the Sorocaba Falls,

which are approximately 600 ft. in height, and purchased the German concessions and rights. The transfer involved the assumption of certain contracts for German machinery and equipment planned for a large plant, therefore when the Sorocaba plant of the São Paulo Electric Co. was planned in 1911, a contract was arranged with German concerns for turbines, accessories and penstocks, but the generators and switchboard went to the General Electric Co. and transformers and exciters to Westinghouse Co. of America.

This development was planned for 88,000-volt transmission owing to its distance, 50 miles, from São Paulo. Having in mind the requirements of other cities and towns nearer at hand, other voltages were also adopted. A large transformer or terminal station was built about five miles from São Paulo (See Fig. 1) with the object of supplying a ring distribution system of 40,000 volts feeding into the inner underground and overhead 20,000-volt distribution system. This terminal station is of high-class construction, being a steel-framed building with every convenience for switching, transforming and controlling the incoming and outgoing lines. Up to the present time the 40,000-volt ring distribution system has not been built.

Above the falls, on the river where the Sorocaba hydro-electric plant is located, a monolithic concrete dam is built across the river, containing approximately 68,500 cu.yd. of material, and forms a reservoir of about 160,000 acre-feet capacity. Over the top of the dam is a causeway supported on arches, as shown in Fig. 2. Water from the reservoir enters an open canal through a double-screened intake tower in the dam with sluice gates at different levels and then enters two short sections of closed conduit having butterfly valves 9 ft. diameter for emergency in case trouble is experienced with the sluice gates, and finally enters a canal. This canal winds in and out of the ravines and hillsides, with sand traps and spillways at convenient points for some 8,000 ft. and then enters a tunnel section about 1,700 ft. long, to reach the surge tank, shown to the right of *X* Fig. 5, at the top of the penstock incline. A close-up view of the surge tank is shown in Fig. 6. Valves of the butterfly type motor-operated from the power station are installed in the penstocks at the surge tank. These penstocks are 52 in. diameter; three are installed with provision made for two more. They are constructed of seamless welded steel tubing, heavily anchored to the rock of the hillside, which had to be blasted out, not only for the pipes, but also for two cable construction railways having a maximum grade of 65 degrees.

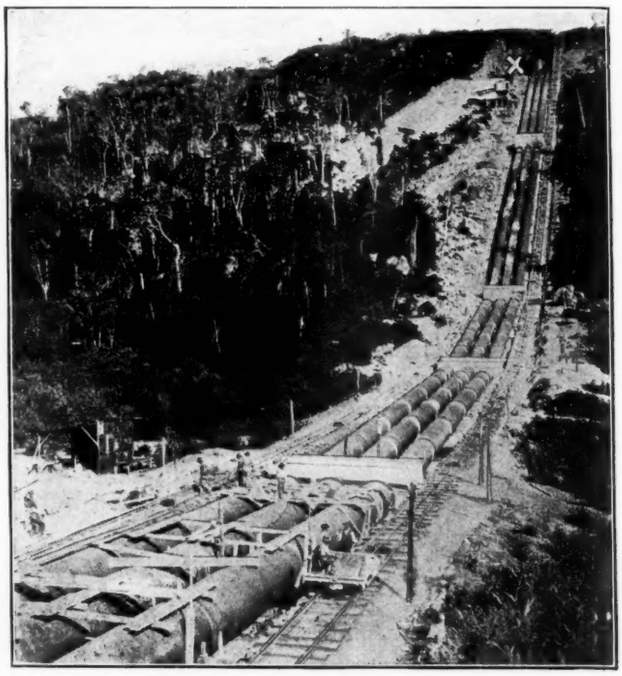

FIG. 5. SEAMLESS WELDED STEEL PENSTOCKS

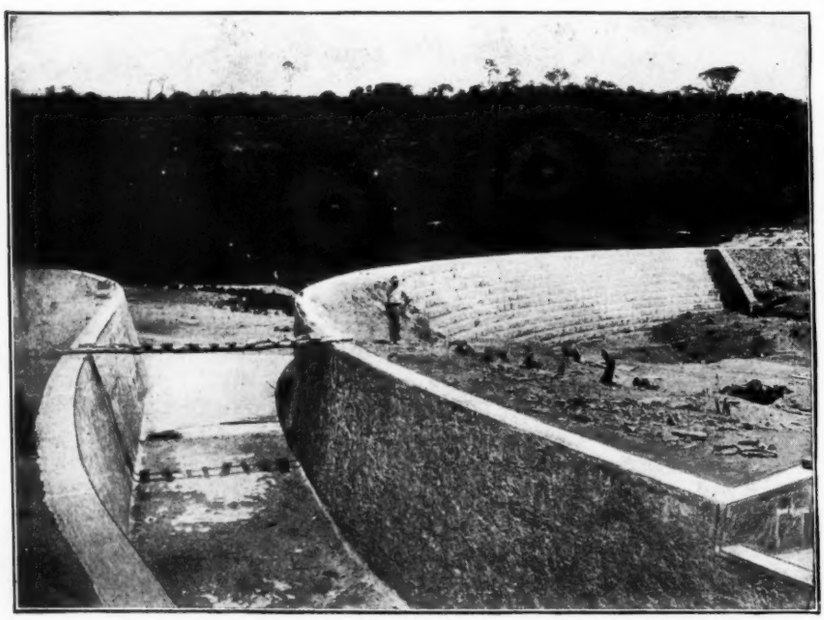

FIG. 4. VIEW OF CANAL AND ONE OF THE SMALL RESERVOIRS FORMED ALONG ITS ROUTE

This general description would not be complete without mentioning some of the collateral undertakings necessary in a project of this kind in a foreign counrty. Roads, of course, were practically impassable for vehicles in this mountainous region and only trails were available, so the rail and the horse had to be used to the fullest extent. All the machinery for this plant had to pass over a greater number of differently gaged railways with differing tunnel and bridge clearances than any plant previously built. There was the 1.60 m. line from Santos to São Paulo, then the one-meter gage of the Sorocabana, then the 60-cm. gage of a gasoline-engine-driven private line from Sorocaba Station to the power-house site, a line replete with exciting features. The equipment along the pipe lines, in addition had to be transported up the steep inclined cable motor-operated one-meter gage railway. All material for the canal, dam and reservoir, after being transported up the incline railway, was transferred to a steam-operated 60-cm. gage traction line 1.5 miles long to the dam.

Nearly all changes of gages required hoisting and reloading. It was necessary to provide a very complete layout of buildings such as stables for horses, a hospital, living quarters for the engineers and camps for the workmen, a machine shop, sawmill, stone-crushing plant, and to develop a water-supply and sewage system and fight the mosquito. Old haciendas or farmhouses had to be equipped with modern plumbing and a group of permanent houses for the engineers constructed to make life bearable for the operating staff.

It should be stated, however, that this part of Brazil provides an intelligent and efficient class of laborers and mechanics and good ordinary foremen among the Italians, Spanish, Portuguese and Germans, but all the engineers on the job were Americans. The foreign population in Brazil has not yet acquired all the objectionable habits of the native Indian or African stock, and consequently work was fairly continuous except on the numerous holidays. A high class of masonry work was done by the Italians and Spaniards, as will be noticed by a look at the canal, dam and power house. The last (Fig. 3) is not of concrete as would appear, but is made of native rough brick of irregular section laid up roughly and then finished off with a layer of stucco, giving it a substantial and high-class appearance. All the structural steel was shipped from the United States. The structural and architectural plans were made under the direction of the writer. Local contractors were secured where possible to furnish the labor, brick, sand and stone, or the company's engineers took charge of the handling of these materials, but all cement, steel, finished lumber and general equipment were imported. The crane, windows, glass, plumbing and miscellaneous electrical equipment were secured from various contractors in America.

There was thus the necessity of continuous watchfulness on the part of the designing and purchasing

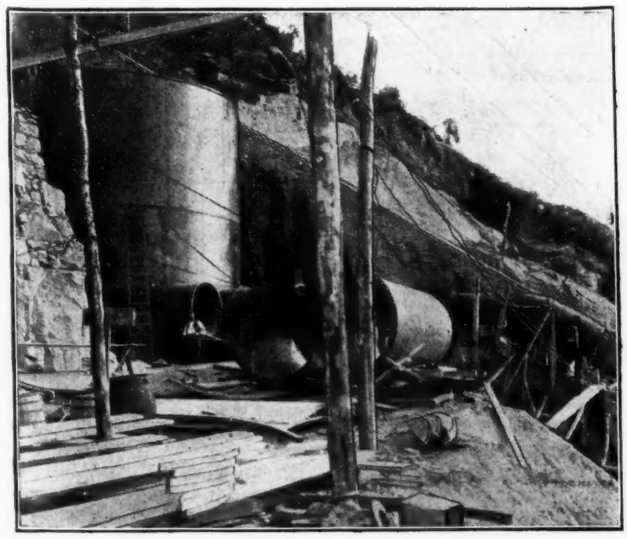

FIG. 6. CLOSE-UP VIEW OF SURGE TANK

engineer in co-ordinating apparatus, plans and ideas which were in different languages and in both metric and English dimensions, and in harmonizing the various offices and fabricating plants, which were in New York, São Paulo, Rio Janeiro, Pittsburgh, Schenectady, Heidenheim, and many other places, thousands of miles apart.

In the plant provisions are made for the installation of five 15,000-hp. units, three of which have been installed. The wheels are of the horizontal Francis type with single inflow and double discharge and operate under a net effective head of 590 ft. and run at 600 r.p.m. They are equipped with wicket gates, and each unit has a flywheel to assist in regulation. Directly connected to each wheel is a 12,500-kva. generator. Three-phase 60-cycle current is generated at 6,600 volts and is stepped up by three single-phase transformers for each generator to 88,000 volts for long-distance transmission and to 24,000 volts for local distribution around Sorocaba.

An exciter and turbine of 700-hp. capacity is fed by a penstock connected to all the main penstocks. There are also two 600-hp. motor-driven exciters.

Each transmission-line circuit has a capacity of 40,000 hp., in an emergency and there are two of them with right-of-way for two more. These latter have been under consideration for some time but are not yet installed.

The company was fortunate in having in charge of the plant installation and operation from the start, J. M. Smeaton, formerly of the Winnipeg plant owned by the same interests as the Sorocaba plant, and in having as manager W. G. McConnell, an American engineer. It is a pleasure to visit these plants as the writer has done and be entertained in American style. One may here even in the wilds find all the American comforts and turn from the consideration of power-plant engineering problems to the enjoyment of his favorite pastime in more than one way.

Taking Indicator Diagrams

BY P. A. BAUMEISTER

Much has been written on the subject of indicator diagrams and many diagrams have been published, but the men who can take really good cards are few and far between. The reason is simple enough—an indicator is a delicate mechanism requiring careful handling in order to get results. The average engineer takes only a few diagrams at rare intervals and therefore is not familiar enough with his apparatus to take the necessary precautions to get satisfactory results. It is the intention of this article to point out the requirements and necessary steps for getting good indicator diagrams.

In order to understand the problem it will be well to consider what an indicator diagram really is. Its name defines it. It is a diagram indicating, for any position of the piston, the pressure existing in the cylinder at the particular time when the piston is in the given position. In practice it is impossible to place the indicator in the cylinder and, therefore, it becomes necessary to have a pipe, port or connection leading from the cylinder to the indicator. This introduces the first source of possible error. This passage should be as short as possible with few turns and a clear opening. The air, steam or gas in the passage leading from the cylinder to the indicator piston is a compressible fluid and does not respond instantly to changes in pressure. That is, there is a time lag introduced here which is reduced to a minimum by keeping the passage as short as possible. In practice this means an indicator at each end of a double-acting cylinder. The ordinary manifold and three-way cock is not suit-

able when accurate diagrams are desired, although it may be good enough for ordinary valve-setting diagrams.

There is little to be said as to the indicator itself, as any good make can be used with success. The preference is for the outside-spring type with a real lead point. Metallic points can be used but, because of the greater pressure required on the point to trace the diagram, there is more friction set up between the pencil and the paper, with the result that it is not so sensitive to slight changes in pressure. A well-sharpened lead lightly pressed against the drum giving a fine line obtains the best results. When properly set, this line is not continuous but is a series of fine points, as shown by Fig. 1, thus giving a minimum of friction between the point and the paper.

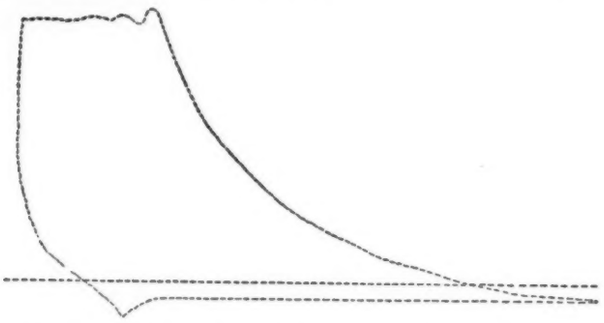

FIG. 1. DIAGRAM LINES A SERIES OF FINE POINTS

The indicator piston should be well oiled and free in its cylinder. When the spring is disconnected the weight of the pencil arm should be sufficient to move the piston in its cylinder. If this is not the case it is probably because of dirt or rust on the piston, causing it to bind. If it does bind it should be carefully cleaned, touched up with fine emery cloth, if necessary, and oiled.

All play between the indicator piston and pencil motion should be eliminated, as play at this point causes the pencil point to lag behind the indicator piston. This play is shown on the indicator diagram by a horizontal line. For example, consider the compression stroke of a compressor where the pressure is constantly changing; if, at the beginning of the stroke, the diagram looks like Fig. 2, it indicates either a loose indicator piston or play in the motion. The pressure is constantly increasing and the indicator piston is rising but the pencil point fails to move, causing the horizontal line. When the play is all taken up there is a sudden movement of the pencil point which does not record the true pressure changes taking place in the cylinder.

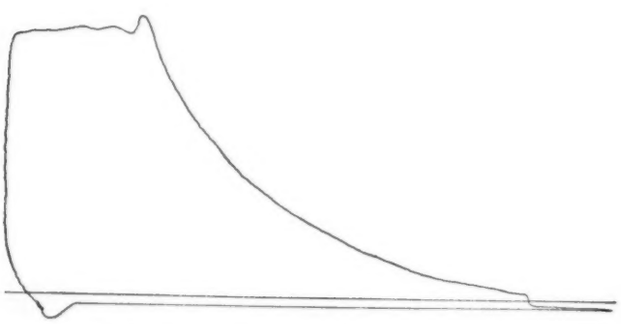

FIG. 2. JUMP AT BEGINNING OF COMPRESSION-STROKE INDICATES INDICATOR LAG

Either before or after use indicator springs should be calibrated. This can be done by connecting the indicator on a gage-tester and drawing horizontal lines for various pressures; see Fig. 3. By scaling these lines and comparing with the weights on the tester the true scale of the indicator spring can be determined.

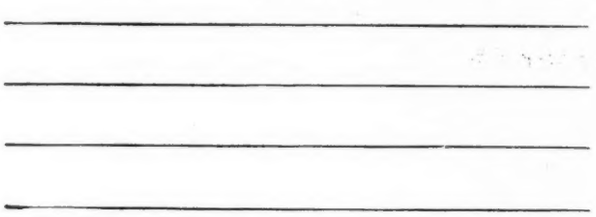

FIG. 3. LINES FOR CHECKING INDICATOR SPRINGS WITH GAGE TESTER

Indicators are generally driven by a cord, which should be of the best possible quality, well stretched. The drum on the indicator tends to lag behind the cord when being accelerated and to over-travel toward the end of the stroke. To overcome this as much as possible and reduce the stretch of the cord, the drum tension should be as great as possible. Connecting two or more indicators on the same driving cord helps in this respect.

Weak drum springs or cord stretch is shown on the diagram by a horizontal line. For example, take a compressor diagram and consider the re-expansion line. If it looks like Fig. 4, it indicates weak drum springs or stretching cord.

In most cases indicators are driven from the crosshead of the machine to be indicated, an arm being attached for this purpose. This arm should be as short and stiff as possible in order to reduce its tendency to vibrate. Last but not least is to see that diagrams are taken simultaneously at all points to be indicated and at frequent enough intervals to get average results.

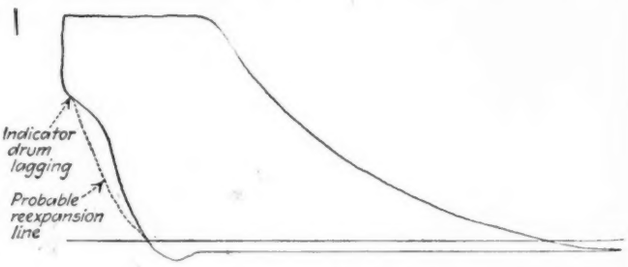

FIG. 4. INDICATING A WEAK SPRING OR A STRETCHING CORD

Cards should be marked with all the information possible—speed of machine, size, spring scale, gage reading, etc., so that they are as complete a record as possible. Other minor thoughts will occur to the operator, such as blowing out all connections to eliminate any pipe scale, condensed steam, etc.

If the reader will stop and consider that it is just little things as pointed out briefly here that mean the difference between just diagrams and real indicator diagrams and give a little thought to analyzing them, he will find that he can obtain good diagrams from which much can be learned.

Manual Versus Automatic Starting of Rotary Converters

By R. J. WENSLEY
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THE automatic converter substation at first glance seems to be an intricate complication of wires, contacts and coils, all of which perform quite incomprehensible duties. This is not at all the case, as the complexity is only apparent; the basic principles are quite simple. The best way to understand the operations that take place in automatically connecting a converter to the line is to follow through the manual starting of a converter and compare it with the automatic operation.

Assume that we are in a modern railway substation with a six-phase commutating-pole converter. The operator has been instructed to start his machine when the trolley voltage drops below 475 volts. The operator occasionally glances at the voltmeter, the needle of which is bobbing back and forth as a car approaches several miles down the line. Finally the needle drops below 475 and stays there long enough to convince the operator that his services are really needed. After a glance at the alternating-current voltmeter and an examination of the converter to be sure that the brushes are raised, he closes the oil circuit breaker and throws the starting switch to the upward, or low-voltage position. If at this time the machine should fail to rotate, he would open the switch and breaker to prevent destruction of the windings by the heavy current that flows when the armature is not rotating.

Automatic substations were first developed to take care of electric railway loads, but they now have been applied to all classes of loads even in the industrial plant. Every power-plant operating engineer is familiar with the manual procedure in starting and stopping electrical equipment, but in most cases is not so clear on how this procedure may be taken care of automatically. In this article the author compares manual operation with automatic and shows in a popular way how the latter accomplishes the functions of the former. Although a railway substation has been referred to, the statements are in general equally true with regard to an automatic converter station used in an industrial plant.

If, however, everything is normal, he waits for the machine to come up to speed and watches the direct-current voltmeter which is connected to the pilot brushes of the converter. This meter will not read until the machine is in synchronism with the line, as the converter acts as a frequency changer while below synchronous speed. The direct-current voltmeter, being a polarized device, will not operate on the alternating-current, but will wait until the converter actually locks into step, at which time it begins to register.

Polarity of Rotary Converter

Now a converter that is started from the alternating-current side has no way of knowing in advance as to what its polarity is to be when it reaches synchronous speed. It is purely a matter of chance and depends on which half of the altenating-current wave it pulls into step on. The voltmeter reading indicates to the operator the polarity of the machine. If it is right, he wastes no more time, but immediately throws the starting switch down to the full voltage or running position. If the polarity is wrong, he throws the double-throw field switch to the opposite position from normal and watches the direct-current voltmeter, which drops down toward zero as the reversed field causes the machine to drop back out of step. Just at the zero point he will (if he is a good operator) throw the field switch back to its original position. The voltmeter will then tell if the operation has been successful. If not he will try one or two times, and if not successful will then open the starting switch and allow the converter to drop out of step. He again closes the starting switch and the converter pulls into step. The same chance exists of obtaining either polarity as at the start. With a modern machine it is seldom necessary to try more than once if the operations are performed at just the right time. With the polarity finally corrected, the transfer to the running tap is made. The brushes are then lowered onto the commutator by manipulating a lever on the machine. The direct-current breaker is then closed, after which the knife switch is closed and the converter is on the line. Now visit a modern automatic substation and compare its operations with what has just been seen. Instead of having an operator to watch the voltmeter an induction-type voltage relay is used, equipped with a contact that closes when the voltage falls to its setting. Instead of the alternating-current voltmeter there is an induction-type voltage relay. This relay is far more accurate than the operator and will not forget to function at the right time. This relay tells the rest of the equipment to proceed by means of a connection which passes through a contact on the converter's brush-operating mechanism (shown mounted, on the base of the machine, Fig. 1), which is closed only when the brushes are up. The operator may forget some time to look at the brushes, but the automatic never forgets.

Polarized Relay Controls Connecting Machine to Line

The brushes being in the proper position, the oil breaker is closed by the pull of an electric mechanism instead of the hand of the operator. The starting switch is also pulled in by a magnet. Not having any operator to watch the direct-current voltmeter, a polarized relay, Fig. 2, is provided, and since there is lots of work for this relay to do, we make it of the motor construction. This polarized motor watches the polarity of the machine, and as soon as synchronism is reached, it revolves until one or the other of its contacts is closed, the particular one depending on the machine's polarity.

Now referring back to the manual station, it will be remembered that the operator threw the starting switch to the running position as soon as the direct-current voltmeter indicated correct polarity. The polarized motor relay in much the same fashion reaches out and throws the machine over onto the running taps of the transformer. But if the polarity is reversed, the polarized motor relay promptly throws the field switch. Now the motor relay does not have a nice sense of quantities; it is only a sure indicator of polarity. Accordingly, there is a field-reversing relay which watches the converter to reach zero voltage. At a point very near to zero this relay causes the field switch to throw back to its original position, after which the converter usually comes up right. This automatic control has a better chance of bringing the converter up right the first trial than the operator because the relays are not likely to make an error of judgment. If the polarity does happen to again come up wrong, the polarized relay will go through the same sequence. In the meantime a notching relay counts the attempted polarity reversals and at the third try opens the starting switch for a short time and allows it to close after the converter is out of step, all in quite the same way as the operator. This added feature is only a safety device since it is seldom if ever needed.

Connecting Converter to Its Load

When the alternating-current running switch closes in response to the polarized motor relay, it in turn reaches out (electrically speaking) and energizes a motor which is geared to the brush-operating lever and thus lowers the brushes onto the commutator. An inter-

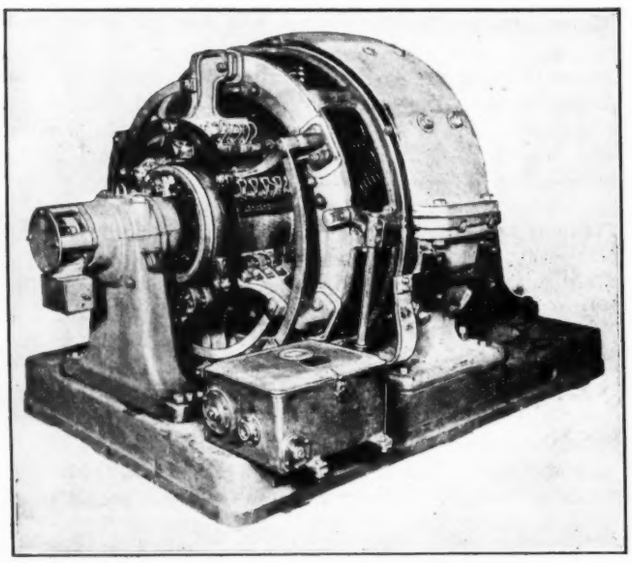


FIG. 1. BRUSH-OPERATING MECHANISM APPLIED TO MODERN CONVERTER

A relay circuit connected through the contact on the brush lifting mechanism prevents the converter from being started if the brushes are not lifted.

lock contact on the brush mechanism signals the direct-current switches that the converter is ready to carry load.

Here comes the greatest departure from the manual method of operation. In the manual station the operator trusts to luck that the line may be clear. If it is not, when the switches are closed the carbon breaker will fly out, making considerable fuss in doing so. Not so in the automatic station. Here the converter is first connected to the line through several banks of grid resistance of such value as to limit the load under the worst conditions to one and one-half times normal. If the amount of load picked up through this resistance is less than a certain amount, a series relay finds it out

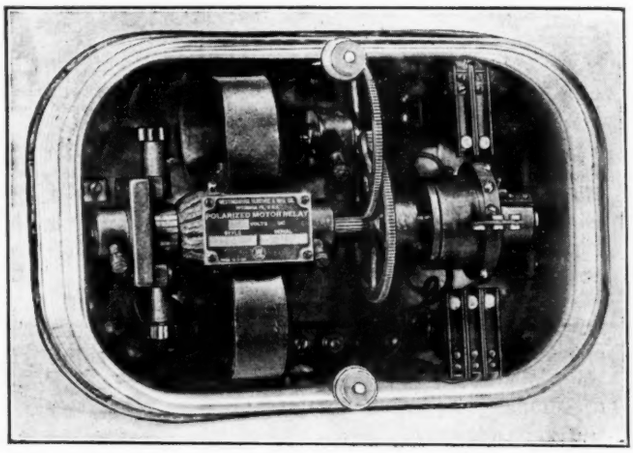


FIG. 2. POLARIZED MOTOR RELAY

This relay watches the polarity of the converter and prevents the machine being connected to the direct-current system until correct polarity is obtained.

and tells another direct-current switch, which short-circuits part of the resistance, after which another series relay makes an inspection and if conditions warrant, closes another direct-current switch. This is repeated a third time, which causes the last direct-current switch to close and thus short-circuit all the resistance. This connects the machine to the line and leaves it in full operation. The series relays remain right on the job and, if a short-circuit or an extreme overload occurs, will cause the resistance to be inserted in sufficient amount to protect the machine. In the manual station the operator took several minutes to put the machine on the line, but in the automatic station the machine is on the line carrying load in about 30 sec. if a small converter or in any case in less than a minute.

Current-Limiting Resistance

The current-limiting resistance is designed to limit the current that the machine will take to 50 per cent overload. The grids are designed to carry such a load for a period of five minutes, after which they reach a temperature that will operate a thermostat, the element of which is mounted directly over them and shuts the station down. After the grids have cooled again to a safe operating temperature, the contacts of the relay are automatically reset and allows the station to again start. This will continue until the trouble is cleared. The usual time for cooling of the grids is about 15 or 20 minutes. It is not necessary for an operator to visit the station to secure this restarting.

Returning to the manual station, the operator has been instructed to shut down the machine when the load remains below 15 per cent of full load continuously for five minutes. We find the operator with watch in hand reading the ammeter and waiting for a continuous period of five minutes with less than the specified minimum load (operating men will recognize that this is not a real operator; in real life he is frequently sitting out in front reading a magazine). When the specified conditions have been met, the machine is shut

down by opening the direct-current breaker, oil breaker and running switch. In the automatic station, an underload relay measures and indicates when the load is less than the minimum. At such times as the load is less than the specified amount, this relay is counting time by means of a motor-driven time relay, Fig. 3. This time

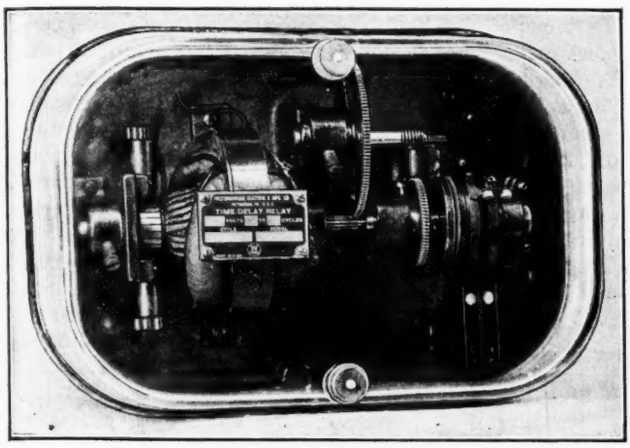


FIG. 3. TIME-DELAY RELAY
This relay controls the underload relay so that the latter cannot shut the converter down until the load has remained under the minimum value for a specified time.

relay has an instantaneous reset so that the underload relay must remain in contact continuously for the time setting of the relay before the station will shut down.

In the hypothetical manual station the operator again watches the direct-current voltmeter for another indication that the station is needed. In the automatic station the direct-current voltage relay is on the job just waiting for a chance to start the station. In practice it is quite impossible to persuade an operator to watch the load requirements so closely. The practice is therefore to let the machine run continuously, even though the light-load losses are high. The automatic station operates only for a sufficient amount of time after the load drops to allow for a normal car stop. The automatic consequently saves in power as well as in operating labor.

To return to the hypothetically perfect operator, we find him hovering over the machine all the while it is running, feeling the bearings and the windings to see if there is any excessive heating. In the automatic station there are thermostats in bearings and a thermal relay in the machine circuit to catch the overheating, and these devices are on the job for 60 sec. out of every minute the machine operates. This relay has a time-temperature characteristic which is very similar to that of the machine. Should the copper in the machine reach a temperature that would be detrimental to the insulation, the contacts of this relay close and cause the station to shut down. The time-temperature characteristics being similar, by the time the relay contacts have been automatically reset, the machine has cooled down to a safe operating temperature, after which time the station is released and goes back into service without the attention of an operator, and if further trouble develops the machine is again cut out automatically.

Our well-trained operator is so well acquainted with the sound made by the converter that he immediately recognizes the change in tone when line trouble occurs. In the automatic station we have the phase-balance relays to trip out the machine if dangerous unbalanced conditions should occur. If the trouble is in the high-tension supply, these highly intelligent relays trip out the control, but leave it in condition to restart when the line is again made alive on all phases. If the trouble is in the low tension, the station is locked out until visited by an attendant.

Both in manual and in the automatic stations we have reverse-current relays and overspeed trips to save the machine from running away due to reverse flow of direct-current energy to the machine. The automatic will respond to kind treatment like any good servant. If it is carefully groomed once a week, it will give the best kind of service.

Automatic converting substations are, in general, applicable to any sort of industrial requirement where operating labor can be saved by using them. Proposals have been made for their use in various types of mills and factories, motion-picture studios, electrolytic industries, mines and many other applications. In some cases the prospective purchaser has been more eager to eliminate the operator than to save labor cost, since the problem of keeping maintenance men seemed much easier.

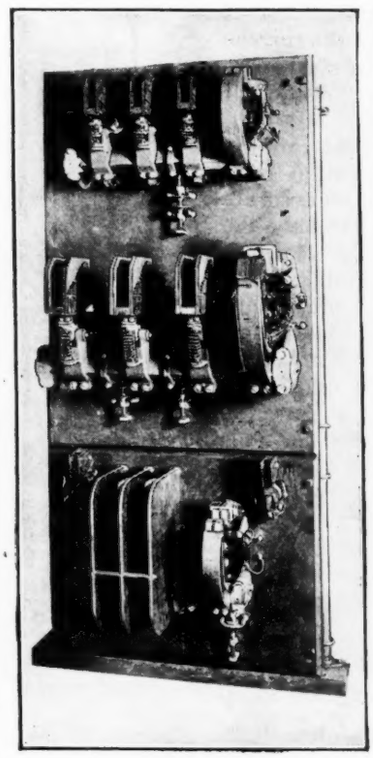


FIG. 4. ALTERNATING-CURRENT AND FIELD SWITCHES

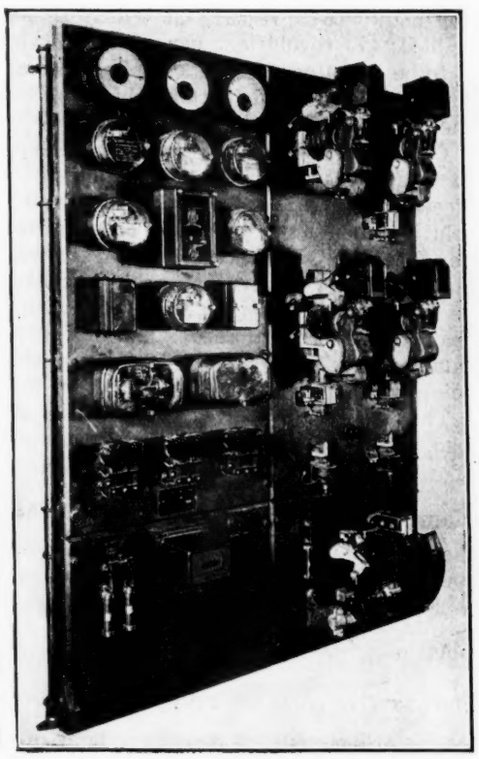


FIG. 5. CONTROL RELAYS, INSTRUMENTS AND DIRECT-CURRENT SWITCHES

On these three panels are mounted all the contactor switches, relays and instruments for automatically starting and stopping the converter. The machine is started automatically from the alternating-current side when the load on the direct-current system exceeds a certain value. When the load on the direct-current system falls below a given value and remains there for a period the machine is shut down automatically.

Estimating Steam Consumption of Bleeder Turbines*

BY JOSEPH GERSHBERG

THERE are many industrial plants where the installation of a bleeder turbine would result in a considerable saving of fuel. For this reason it is important that there be a more general understanding of the steam-consumption characteristics of this type of prime mover. This article explains and illustrates a convenient method of estimating the steam consumption of a bleeder turbine at a given load and with a given amount of steam being bled. Aside from the data obtainable from the diagram, the only information needed is the non-bleeding steam consumption of the turbine at the given load and at full load.

The bleeder turbine is essentially of the same design as the straight condensing turbine except that the former is provided with means of extracting a required quantity of steam after it has performed a certain amount of work within the turbine. A bleeder turbine may be designed to give just as good steam consumption when operating straight-condensing (that is with no bleeding) as a standard straight-condensing turbine operating under similar steam conditions.

The steam consumption of a bleeder turbine depends on a large number of conditions, including the following: (1) Rated capacity of the turbine; (2) pressure at the turbine throttle; (3) steam quality at the throttle; (4) vacuum maintained at the exhaust of the turbine; (5) quantity of steam to be bled, in pounds per hour; (6) pressure at which this quantity is to be bled; (7) revolutions per minute at which the turbine is to be operated; (8) relative importance of steam consumption with and without bleeding; (9) design of the turbine.

On account of the large number of these determining factors the problem of the steam consumption of a bleeder turbine is too complex to permit of an accurate solution by simple formulas or diagrams, if only the non-bleeding steam consumption at various loads is known. It is, however, possible to make a diagram of general application that will give, with no other data than this, a rough approximation of the steam consumption at any load and with any amount of steam being bled. Such a diagram is shown in the figure.

This diagram involves, in addition to the per cent load, the four quantities B, F_{100}, F_B and F_C, the meaning of which is explained on the diagram. To use the diagram, enter it at the bottom with the quantity $\frac{B}{F_{100}}$ the ratio of the steam bled to the non-bleeding steam consumption at full load. Rise vertically to the line representing the per cent load to be carried and then move horizontally to the left, where $\frac{F_B}{F_C}$ can be read. The quantity $\frac{F_B}{F_C}$ is the ratio of steam consumption when bleeding B pounds of steam per hour at the given load to that when operating at that load without bleeding.

*It is the author's belief that his diagram for estimating the approximate steam consumption is practically universal in its application to bleeder turbines within limits stated in the article. Where readers have reliable data on bleeder-turbine performance, *Power* will be glad to learn how closely they agree with results obtained by the use of this diagram.—EDITOR.

In view of the fact that bleeder turbines are used almost exclusively in connection with generator drives, this diagram is intended chiefly for turbo-generators of capacities ranging from 300 to 2,500 kw. operating at steam pressures from 125 to 250 lb. gage and vacuum from 26 to 28½ in. of mercury, and bleeding steam at pressures ranging from a little over atmospheric to 20 lb. gage. It can be used, however, for bleeder turbines driving any other machinery.

To illustrate the use of the diagram, suppose that the turbine, when operated without bleeding, uses 10,000 lb. of steam per hour at full load and 6,000 lb. at half-load. What will be the steam consumption at

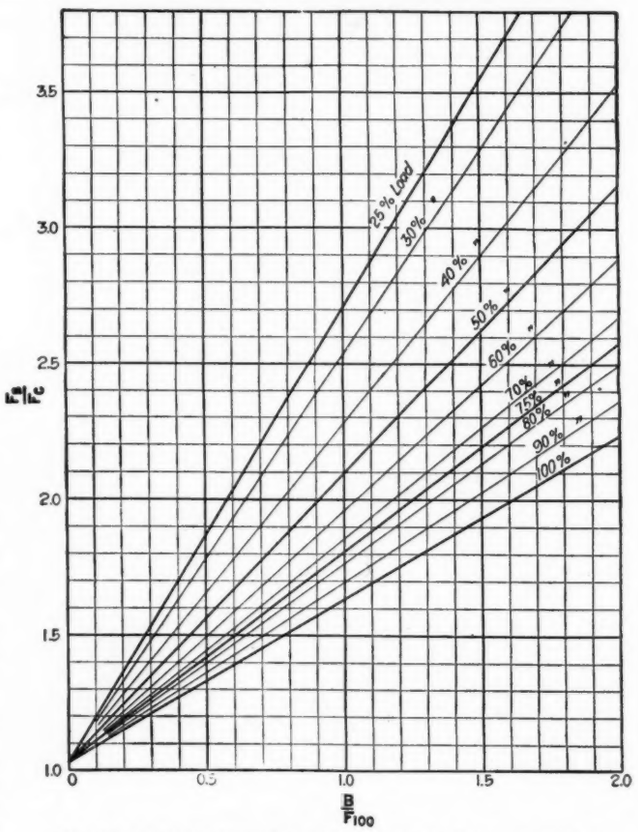


DIAGRAM FOR ESTIMATING STEAM CONSUMPTION OF BLEEDER TURBINES

For turbines 300 to 2,500 kw., 125 to 150 lb. steam pressure, 26 to 28½ in. vacuum, steam bled from 0 to 20 lb. gage pressure.

B = Amount of steam bled in pounds per hour at any load.
F_{100} = Amount of high-pressure steam required in pounds per hour at full load when no steam is bled.
F_B = Total amount of high-pressure steam required in pounds per hour when bleeding B pounds per hour at a specific load.
F_C = Total amount of high-pressure steam required in pounds per hour for the same specific load when no steam is bled.

half-load when bleeding 5,000 lb. per hour? Enter the diagram at the bottom with $\frac{B}{F_{100}} = \frac{5{,}000}{10{,}000} = 0.5$. Move up to the 50 per cent line and then across to $\frac{F_B}{F_C}$. The value of $\frac{F_B}{F_C}$ is seen to be 1.56. This means that the bleeding steam consumption will be 1.56 times the non-

bleeding steam consumption, or $1.56 \times 6{,}000 = 9{,}360$ lb. per hour.

As a further illustration of the application of this diagram, consider a plant of 1,000 kw. capacity, where steam is used both for heating and for manufacturing purposes. For a certain selected set of steam conditions when the turbine is operating straight condensing (without bleeding) let the following steam consumptions be assumed:

TABLE I. NON-BLEEDING STEAM CONSUMPTION OF TURBINE

Per Cent of Rated Load	Kw.	F (Total Steam Flow, Lb. per Hr.)
0	500	9,600
75	750	13,300
100	1,000	17,000

Suppose the demand for steam to be bled at 5 lb. gage pressure consists of 15,000 lb. per hr. during 3,000 hr. per year for manufacturing purposes and an additional 5,000 lb. per hr. during 1,500 hours per year for heating purposes.

During a cold season the total flow of steam (F_B) required for bleeding 20,000 lb. per hr. at various loads is determined as follows: The ratio $\frac{B}{F_{100}} = \frac{20{,}000}{17{,}000} = 1.18$, and F_B will be as worked out approximately in Table II.

TABLE II. TOTAL STEAM REQUIRED BY TURBINE IN COLD SEASON, BLEEDING OPERATION

Per Cent Rated Load	Kilowatts	$\frac{FB}{FC}$ (From Diagram)	FC	FB (Total Flow Lb. per Hr.,
50	500	2.29 ×	9,600 =	22,000
75	750	1.95 ×	13,300 =	25,900
100	1,000	1.74 ×	17,000 =	29,600

In the warm season, when bleeding only 15,000 lb. per hr. the required total flow (F_B) at the same loads $\left(\text{for ratio } \frac{B}{F_{100}} = \frac{15{,}000}{17{,}000} = 0.88\right)$ is as worked out approximately in Table III.

TABLE III. TOTAL STEAM REQUIRED BY TURBINE IN WARM SEASON, BLEEDING OPERATION

Per Cent Rated Load	Kilowatts	$\frac{FB}{FC}$ (From Diagram)	FC	FC (Total Flow, Lb. per Hr.)
50	500	1.97 ×	9,600 =	18,900
75	750	1.71 ×	13,300 =	22,700
100	1,000	1.56 ×	17,000 =	26,500

Now let us ascertain the saving obtained from the use of a bleeder turbine by comparing the case cited with the one where a 1,000-kw. straight-condensing turbine is employed to deliver only the required power while steam for manufacturing and heating purposes is drawn directly from the boilers through a reducing valve. Suppose that steam for manufacturing purposes is used up completely—that is, without returning an equal amount of condensate to the boilers—while steam for heating purposes parts only with its latent heat, after which the condensate is again available for the boilers.

One pound of dry saturated steam at 150 lb. gage, or 165 lb. absolute, contains 1,195 B.t.u. If reduced through a valve from the boiler pressure to 5 lb. gage (20 lb. absolute) and then used for heating purposes, this pound of steam will liberate 1,195 — 196 = 999 B.t.u., where 196 B.t.u. is the heat of the condensate at 20 lb. absolute.

If this steam had been passed through a turbine of average efficiency and bled at 20 lb. gage, it would have lost only about 10 per cent of the heat available for heating purposes. As a matter of fact it can be shown that for initial pressures ranging from 125 to 250 lb. gage, steam bled at 20 lb. pressure will have on the average about 90 per cent of the usefulness for heating purposes of steam passed through a reducing valve. The effect of different turbine efficiencies, steam pressures, etc., on this figure is too small to be worth considering in making rough estimates.

Therefore, in the case where live steam is used for manufacturing heating purposes, the quantity of such steam becomes $15{,}000 + 0.90 \times 5{,}000 = 19{,}500$ lb. during a cold season, and 15,000 lb. during a warm season. These quantities, added to that required for power at various loads, give the total demand of steam as shown in Table IV.

TABLE IV. STEAM REQUIRED BY PLANT, NON-BLEEDING OPERATION

Per Cent Rated Load	Kilowatts	Flow, Lb. per Hr. for Power Only	Total Demand of Steam, Lb. per Hr. Cold Season	Total Demand of Steam, Lb. per Hr. Warm Season
50	500	9,600	29,100	24,600
75	750	13,300	32,800	28,300
100	1,000	17,000	36,500	32,000

A comparison of Tables II, III and IV reveals a decided saving of steam with a bleeder turbine. With coal at $5 per ton and an evaporation of 8 lb. of water per pound of coal, this saving, translated into dollars and cents, is shown in Table V.

TABLE V. SAVINGS OBTAINABLE BY USE OF BLEEDER TURBINE

	Cold Season			Warm Season			Savings for Whole Year	
	Savings for Season			Savings for Season				
Per Cent Load	Steam Lb./Hr.	Coal Tons		Steam Lb. per Hr.	Coal Tons		Coal, Tons	
50	7,100	665	$3,325	5,700	534	$2,670	1,199	$5,995
75	6,900	646	3,230	5,600	525	2,625	1,171	5,855
100	6,900	646	3,230	5,500	515	2,575	1,161	5,805

Apart from the saving indicated in Table V, there results an added saving because boilers of smaller capacity may be installed.

It is interesting to note that the saving in fuel is practically independent of the load carried by the turbine. This is only approximately true and depends on the design. The saving is slightly greater at smaller loads.

In conclusion it may be said that the bleeder turbine is now recognized as an effective means of reducing fuel consumption in a great variety of industrial plants. Whether its installation in the plant of a prospective user will prove of value can be approximately ascertained by using the diagram in connection with the estimated water rate of the turbine when operated without bleeding. Should this preliminary investigation indicate a possible saving, a closer estimate can be made by obtaining the actual guaranteed steam consumptions from the turbine manufacturer.

In fuel-oil burning plants it is essential that the system be kept at a sufficiently high temperature to insure low viscosity of the oil that is being handled. For most grades of fuel oil the prevailing practice prefers temperatures from 90 to 100 deg. F. up to the heaters beyond which, for low-pressure-steam atomizing systems, ranges of from 130 to 160 deg. F. are usual. For high-pressure mechanical systems the best results in the furnaces have been obtained with a range of from 200 to 280 deg. F. at the furnace. The most suitable temperature will, of course, depend upon the relation between the temperature and the viscosity for the grade of oil used.

Power-Plant Accounts—V. Indirect Expense (Continued)

By WILFRED A. MILLER

THE elements entering into the cost of manufacturing power are most conveniently divided into two distinct groups—those which may be designated as Direct Expenses and those which come under the heading of Indirect Expenses. With the former we are already familiar. They consist of Labor, Fuel, Water and so on. Of the Indirect Expenses we have, so far, made the acquaintance of only one, Depreciation. That there are others is a fact dwelt upon in a preceding discussion. What they are remains to be seen. Their number and significance will vary with the particular installation under consideration, but a representative list may be said to consist of the following: (1) Depreciation, (2) Taxes, (3) Interest, (4) Insurance, (5) Obsolescence, (6) General Charges.

At first sight it may seem far fetched, or even actually erroneous, to make the statement that taxes, insurance, interest and the like, are part of the expenses of manufacturing power, but let us see whether that is so or not. We shall leave the first item, Depreciation, out of the discussion because we have already convinced ourselves that it, at least, is really an expense incidental to the generation of power.

This is the fifth of a series of articles written in conversational style and treating the subject of power plant accounts in a thorough, yet simple manner. They were prepared primarily for the guidance of the operating engineer who wants to keep track of the cost of the power he is making, but who knows nothing at all about bookkeeping. Others may find these articles helpful in clearing up their ideas on the subject. This installment starts by reviewing part of what has gone before and then takes up the following six items of Indirect Expense: Depreciation, Taxes, Interest, Insurance, Obsolescence, General Charges.

In arriving at some conclusion regarding the other items in the list, suppose we take each one up in its turn and see what we can find out about it. First, after Depreciation, we find the item of Taxes. What are taxes? They may be of different kinds, but if we can come to some conclusion in reference to any one of them, we can apply like reasoning to any others. The kind of tax that comes most readily to mind in this connection is the tax on land and buildings. Every year there is made out against us, by the proper official of the town or city in which our plant is situated, a bill charging us with a certain tax because we are the owners of property in the town or city. The amount of the tax depends on the tax rate in the particular town or city and the value that the officials put on our factory.

It is assumed in this discussion that we own the land and buildings that constitute the factory. If we do not, the tax on the property cannot be levied on us, but is, instead, levied on the owner from whom we rent the premises. In that case we would, of course, not be called upon to pay such a tax and it would not appear among our items of cost. On the other hand, we would be paying rent to the owner, and this item would then have to be inserted in our list to take the place of the one for taxes on land and buildings. It often happens that leases for the rental of given premises are made out in such a way that the concern that intends to occupy them obligates itself to pay the taxes in addition to a specified rental to the owner. In both cases we would have to pay the taxes and rent, and both items would therefore have to be represented in our list.

Whatever form they may take, the fact remains that taxes are an expense for which the concern must pay out good money. The question before us then is, shall we allow any of the taxes to be charged to the generation of power, and if so, how much? To get a clearer view of this problem, let us suppose that the power plant is situated at one end of the grounds with independent means of entrance and egress to the street so that it could be cut off from the rest of the factory without interfering with one or the other. Such being the conditions, let us say that the proprietor of the factory comes to us and says: "Look here! I am going to make you a proposition. The public-service people tell me that they can furnish power for less than we are making it. I know you don't agree with them and that you feel that you are making it for at least 20 per cent less than they can furnish it for, and maybe you're right, but we've no means of proving it, because we have never put in a system of cost finding. Now I'll tell you what we'll do. We will sell you the entire power plant at a fair valuation, including land, buildings and all the equipment, and make a contract with you to buy all our power from you if you will agree to sell it to us at 10 per cent less than the public-service price. In that way we will know for sure that we are getting our power cheaper than we can buy it on the outside, and you will be making a profit of approximately 10 per cent on all the power you sell us." For the sake of the argument let it be supposed that we are in a position to accept such a proposition and do so. Since we have become the owner of the property that constitutes the power plant, the city will now split the tax it used to levy against the entire factory, and part of it will be levied against us, the remainder still standing against our former employer.

Now what happens? We must, of course, pay the taxes and add them in with the rest of our expenses. Thus, at the end of the year we find that we have spent a certain amount of money for wages, for coal, for water, for lubricants, and finally for taxes. All that money has to be paid out of what we receive for the power we delivered before we can show any profit. If we didn't take the money for the taxes out of the money received for our power, where would we get it? We would simply have to pay it out of our own pocket, which would not be getting us anywhere, as we would of course have to take that much out of the profits to pay ourselves back.

Looking at it from this angle makes it quite clear that taxes are really one of the items of expense of generating power. Just because the power plant happens to be a part of the entire factory, does not alter the case. Every kilowatt-hour generated, every pound of steam passing out to the various buildings, uses up a fraction of the taxes paid by the owners, because if the power plant were not there the owners would be required to pay just that much less in taxes.

What applies to taxes applies with equal force to interest. Thus, in our hypothetical example, the owner might have said to us, "You needn't pay us the whole thing right away. If you can put up $2,000 now, we'll let the rest stand until you can pay it off, if you will pay us 6 per cent a year interest on it until then." In that case we should have to pay him that much interest every year until we were able to pay off the balance of the purchase price. The only way of raising the money would be out of the sale of power, and so, as in the case of taxes, we would find that interest is one of the expenses of carrying on our business.

Precisely the same arguments that have been advanced in the case of taxes and interest apply to the item of insurance. The presence of the power plant adds a certain amount to the insurance premium which the concern must pay, and it is therefore only right that this amount should be charged in as one of the expenses of supplying power.

Obsolescence and General Charges

We have now disposed of the four most usual classes of indirect expense. There remain Obsolescence and General Charges. In most isolated plants of moderate size the item of Obsolescence need not be given much consideration, but we may as well devote a little attention to it in order to understand what the term means, since we may on occasion run across it as an item of expense. Broadly speaking, obsolescence may be said to be the "dropping behind the times" of a piece of apparatus. An illustration will probably be of greater assistance in explaining the term than any number of definitions that might be given. Thus, let us take the case of a large power station that put in a big turbine unit, say ten years ago. After careful figuring it is found that today a unit can be bought that will operate so much more economically than the old one that the cost of the new unit can be earned in two years merely by the saving in steam in that time. No one would hesitate to throw out the old unit and install the new one under such circumstances, provided the money to buy the new one is available. It would even pay to go out and borrow the money in order to get the new unit. The reason the old unit is thrown out is because it has become obsolete—behind the times. That is, due to obsolescence, its value has tumbled to that of mere scrap, although it is only ten years old.

It may be argued from the foregoing that obsolesence is really nothing but depreciation, and that it is therefore only adding an extra complication to the accounting to call it by another name. Such, however, is not the case. Depreciation, we will remember, is the gradual wearing out of a piece of apparatus. If the life of the turbine in our example were estimated at 20 years, it would have depreciated not more than half its original cost in the ten years it was in use, whereas we actually find that we are disposing of it for its scrap value, which is only a small part of the other. This drop in value is due to something entirely different from the wearing out of the unit. So far as that is concerned, it might be in prime condition and capable of operating at its rated efficiency for many years to come, maybe more than ten. The drop is due to the fact that a better machine has been invented. If no one had succeeded in building a more economical unit during those ten years that the turbine was in operation, we would never think of scrapping it, since it could not be replaced by anything better. Hence obsolescence is due to advances in the design of appliances, whereas depreciation is due to the wearing out of apparatus in use.

When Obsolescence Can Be Considered an Expense of Generating Power

Really, obsolescence can be considered as one of the expenses of generating power only when it is a foregone conclusion that some of the apparatus is going to become obsolete within a given number of years. In that case the first cost may be divided by the number of years which it is estimated will elapse before the apparatus, whatever it may be, becomes antiquated, and this amount may be entered as one of the expenses for the year. When we pursue such a policy, it is of course unnecessary to charge any depreciation of this particular piece of apparatus, since the obsolescence is already taking away more of its value each year than the amount of it which we are "using up" in that time.

The remaining classification, General Charges, serves to take care of any odd items that may crop up from time to time and that do not belong under any of the specific headings preceding it in the list.

Now that we understand why the items that we call Indirect Expenses must be included in the cost of generating power as well as the more apparent Direct Expenses, the next question before us is how to apply these expenses and in what amounts. Here again we shall find it desirable to take up each class by itself and dispose of it before proceeding to the next one.

The first item in our list, Depreciation, has already been discussed quite fully, and it will therefore be unnecessary to treat of it here, except to say that the amount of the depreciation arrived at as the proper charge for the year must be divided by twelve to get the depreciation per month, and that this figure must be entered in our journal each month as one of the elements of expense for that month.

Method of Handling Taxes

The next item to be considered is Taxes. As already stated, we will confine ourselves to that class of tax which is assessed against land and buildings. Other taxes, if there are any, may be treated in a like manner if they can be traced back as being affected by the presence of the power plant. Some judgment may have to be exercised in this connection since the number of kinds of taxes is becoming larger all the time. For example, there is a tax on the freight that we pay on the coal that we use. If we buy our coal from a local dealer, we never come into direct contact with the tax, but if we buy it by the carload or boatload we do; it appears on our freight bill. Many people choose to lump the tax in with the freight and call it all freight. That is all right when the tax does not amount to very much. However, in cases where it totals up to a considerable sum in the course of a year, it is well to keep it separate if for no other reason than that a deduction for it may be made when the income tax return of the

concern is made up for the year. Anyhow, whether the tax is kept separate or is "absorbed" in the freight, the fact remains that it is a proper charge against the cost of making power. If we were not generating our own power, we would not have incurred the tax. On the other hand, because the freight on coal is chargeable to power, this is no reason for charging, for example, the freight tax on goods that the factory ships, to power. No part of this tax is chargeable to power, because it would be incurred just the same even if the company had no power plant of its own. The foregoing illustrations are given merely to make the point that discretion must be used in the distribution of special taxes.

Income and Excess-Profit Taxes

There is one class of tax which may under no circumstances be considered as an element of cost, either of power or of anything else, and that is income and excess profits tax. Unless profits are made, there is no such tax to be paid, and when there are profits the tax is to be paid out of them before they are distributed among the owners. That is, the income of the owners is reduced by the amount of the tax. It can never operate to make them suffer a loss, since it is levied only on profits and is only a percentage of them.

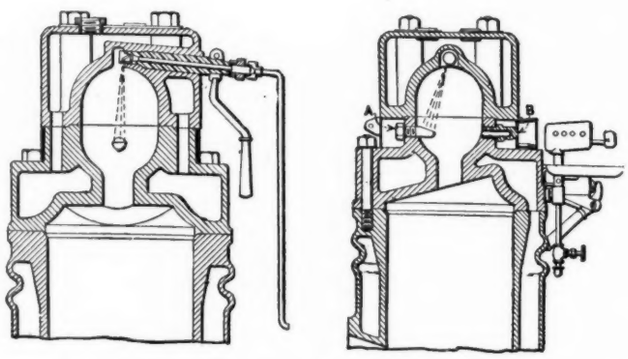
To come back to the principal kind of tax that we shall be called upon to consider, the land and buildings tax, we find that a certain amount of money is paid each year by the concern for such taxes. The amount may vary from year to year, as the tax rate or the assessed valuation of the factory, or both, are changed by the city authorities. Also, the tax bill may be rendered at some time during the year, not necessarily at the beginning. Consequently, it may happen that we do not know just how much tax we shall be called upon to pay until some time during the year, yet must make a charge for taxes each month. When this condition exists, the only thing to do is to estimate how much the tax will be and use this amount. We will seldom be out by very much since we have the previous years' taxes to guide us. Now the tax bill made out by the city lumps together all the land and all the buildings and shows only one total amount for both, so that we have no means of telling from it how much to charge to the power plant, or to any other building. Of course it is necessary for us to know this, and here we shall probably have to enlist the aid of the proprietor or the management.

Unless we are experienced enough to be able to make a good guess, we must find out from someone how much of the value of the property for which we are being taxed, is made up of the land and buildings occupied by the power house. Then the tax can be distributed in proportion. Thus, suppose that the total assessed value were \$500,000 and the tax rate \$2 per hundred. The tax would be $500{,}000 \times 2 \times \frac{1}{100} = \$10{,}000$. Assume that the power-plant part of the assessed valuation was estimated at \$50,000. Then it is plain that the power-plant value is equal to $\frac{50{,}000}{500{,}000} = \frac{1}{10}$ of the total. It should therefore bear one-tenth of the tax or $\frac{1}{10} \times 10{,}000 = \$1{,}000$. Very often the assessed valuation is divided into a total for land and a total for buildings. In that case both may be divided in a manner similar to the foregoing.

When the power plant is large enough to occupy a building or buildings of its own, it is fairly easy to arrive at a valuation of the ground and buildings. When, however, it occupies space in the same building with some other part of the factory, it becomes somewhat more difficult to make such a determination. It then becomes necessary to arrive at some charge per square foot of space occupied and to use this for purposes of tax distribution.

Low-Load Ignition Device for Semi-Diesel Engines

One of the objections against the semi-Diesel engine that is often voiced is the irregularity of ignition on low loads. Engines making use of a water jet can, by proper manipulation of the water valve, control the temperature at all loads. On the other hand, the dry semi-Diesel is handicapped in that if the temperature of the combustion chamber is correct on full load, the radiation loss is such that on partial loads the temperature is entirely too low for positive ignition. The illustration shows the device now used by the Anderson Foundry and Machine Co. on the Anderson semi-Diesel engine. The fuel spray nozzle which rests horizontally in the top of the combustion chamber, can be rotated



IGNITION DEVICE FOR SEMI-DIESEL ENGINES

to give any of three directions to the oil spray. On starting, the starting plug B is heated by a torch, and the oil spray impinges upon the inner part of the plug. When normal speed is reached, and the temperature of the chamber is sufficiently high, the nozzle is shifted, causing the spray to jet downward toward the opening into the cylinder. On low loads the temperature within the cylinder is not high enough to insure ignition without the use of a hot surface. The starting plug does not stay at a high temperature, since the radiation from the outer end is rapid. The low-load plug A at the side of the combustion chamber has but little exposed surface and does not lose its heat. Directing the oil spray upon this red hot plug insures positive ignition regardless of how long the low load continues.

That coal, and not oil, is the basic fuel was emphasized by Dr. Arthur D. Little, chemical engineer, in his speech at the recent annual meeting of the American Chemical Society. He estimated that the present rate of petroleum production can hardly be maintained for more than twenty years, and characterized as indefensible the burning of oil where coal could be used as well, though not, perhaps, as cheaply.

What Fuel Means to America

By HENRY MISOSTOW*

THE animal and vegetable kingdoms are perpetuated by self-propagation. Otherwise the human race, consisting of over a billion persons, would be extinct in less than one hundred years, and the same probably is true of the vegetable kingdom. Minerals, whether organic or inorganic, have not this faculty, and therefore their quantity is fixed. In America the forests so wantonly destroyed may be replaced in one or two hundred years through the present intelligent effort toward reforestation. Our yearly supply of breadstuffs and nearly all the essential foods on which our existence depends is assured perpetually by self-propagation.

The principal fuels, coal and oil, as they exist today, had to go through a process of formation requiring millions of years. Heat and pressure did their work, but the foundation for them, or the substance of the fuels, was produced at one stage of the earth's evolution, which has passed away, probably never to return. The quantity so stored is large but not limitless, and the exact quantity is unknown. Natural gas, so lavishly used, is nearly exhausted; the oil supply in many states is nearly depleted, and in others the depletion is progressing at a tremendous rate. In some states the end of the coal supply can be forecast, and many "played-out" mines are being abandoned.

Fuel is the life blood of the nation. How we use it will determine our future welfare. With over half the world's supply, the quantity used to increase the productivity of labor and maintain a high standard of living need not be limited, but it must be used economically and the fuel reserve maintained to insure commercial success in competition with the cheaper labor of Europe.

Last year the production of all fuels was equivalent nearly to 800 million tons of coal. This amount, equal to 40 billion cubic feet of coal, would cover more than 90,000 acres of land with a layer 10 ft. thick or build the great 1,500-mile Wall of China thirteen times. Allowing about 40 tons per freight car, it would take 20 million cars to move it, making a train about 150,000 miles long. The rate of coal production has been increasing each year, and the end is not in sight.

Oil production and use have reached mammoth proportions, and rivers of oil are flowing from wells into consuming centers, but the backbone of the fuel supply is coal. Fuel being a fixed quantity, the time it will last will depend on the quantity used per year. At best it will be short when compared with the time required for its formation.

The end of the fuel supply will be the end of our comfort. Industry, transportation and even life itself will be difficult to sustain. Such a calamity as a shortage of fuel is no less serious than a shortage of food. In the case of a food shortage better luck may be expected next season and the supply replenished, but with fuel there is no such opportunity when it is once exhausted. The present indifference of the Government and users of fuel can be due only to the lack of realization of what fuel means to the future, and not to indifference to the future.

A nation aspiring to economic greatness and endowed with material wealth as we are should aim to maintain the maximum proportion of its population in productive activities, keep the soil fit for production, conserve all means tending to increase or actually increasing productivity of the population and export only articles ready for use and materials that do not or could not be changed by application of labor or brains to be of greater value. Under these conditions we would utilize to the greatest extent our natural resources and man power. In the light of these facts let us ascertain the tendency of our social and commercial life of today. The daily press probably is the best mirror and, in the field in which we are now interested, sufficiently accurate to justify the following quotation from an article that appeared a few months ago:

> Prior to the World War both Great Britain and Germany far exceeded the United States as coal exporters, despite the fact that we have over half the world's coal supply, while in 1920 and 1921 the United States has taken first rank as a coal exporter and, with the temporary suspension of production in Great Britain, becomes the world's chief source of coal for bunker purposes.
>
> British exportation of coal in the eight months ending with February, 1921, was only 14,000,000 tons, while that of the United States was approximately 30,000,000 tons.
>
> The quantity exported in the eight months ending February, 1921, was valued at $290,000,000 and in the corresponding months of the preceding year at only $93,000,000. The average export price of bituminous coal exported in the closing months of 1920 was $10 per ton in contrast to an average of $5 in the same months of the preceding year, while in 1918 the export price averaged only $2.52. The average value of the coal exported from Great Britain in the eight months ending with February, 1921, was $19 per ton.

Two objections may be raised to the exportation of coal: First, it reduces the supply of cheap fuel which makes possible the extensive use of machinery to increase the productivity of labor, and second, fuel exported at such a low price will enable countries with cheap labor to increase their productivity to a point equal to that of our comparatively well-paid labor. This will drive our goods from the foreign market. Gold, or money for investment, has no country, and gravitates wherever it can secure the greatest return. The present unfortunate condition in Europe, where mere existence is the object, presents a great financial possibility. Skilled and organized labor, willing to work for existence, coupled with machines operated on cheap fuel and cheap American raw material, will be a gold mine for exploitation by capital. America and American standards will be compelled to bow and be replaced by European and Asiatic standards of the war-ruined nations so that, unless we protect ourselves, we will in time be compelled to pay the greater portion of the World War penalty. The coal and iron industries are indicative of American growth in manufacture, commerce and influence. With the growth of the coal tonnage the country grew in wealth and power. The

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tonnage of coal or iron may be said to be the index figure to our economic wealth, and this is true because we actually use both iron and coal to keep our labor employed.

Exportation of coal at low prices will mean, in a short time, unemployment and competition, even for home markets, and substitution of the European starvation standard for the American standard of living will follow, and can be justified only to pay for an unfavorable balance that can be paid in no other way, as in the case of England and Germany before the war.

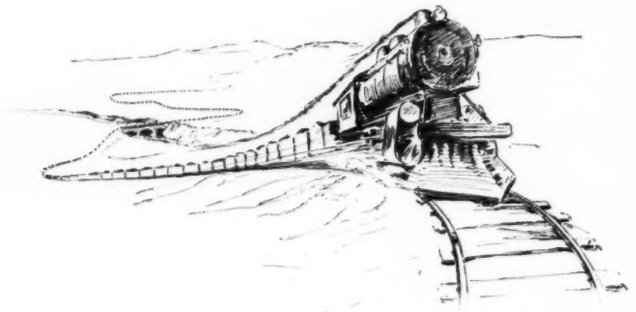


FIG. 1. LAST YEAR THE PRODUCTION OF ALL FUELS IN THE UNITED STATES WAS EQUIVALENT TO 800,000,000 TONS OF COAL. THIS WOULD FILL A FREIGHT TRAIN 150,000 MILES LONG

Suspension of mine operation just for a few days staggered Sheffield, the heart of Great Britain's steel industry. Just imagine how much darker the picture would be if it were a permanent shortage! If the end of the coal supply were closing in on the community, would people have the heart to feed school children or trouble about free-soup kitchens? Depredation and wholesale murder for possession of the few remaining pounds of coal would take place.

With some people conservation is merely a hobby; with others it is a case of dollars and cents, but either or both would not justify this article. Conservation of fuel has much greater significance than a personal affair. It is a stern national duty, as our success will depend largely on the way we manage our fuel supply.

Conservation may be accomplished in two ways—first, by restricting the quantity used with proportional reduction in production and second, by reducing the waste so as to secure the same useful effect from a smaller amount. The first method is not desirable and is not called for. We have enough fuel to encourage its widest use to replace human labor wherever possible. On the other hand, elimination of waste in the use of fuels is not only desirable but indispensable if we are to gain the world's markets and maintain, internationally, what we have gained.

Attempts to conserve fuel by the elimination of waste were made during the war by the Government as well as the people. The high price of coal, coupled with Government supervision, made the consumer more careful. This, no doubt, resulted in some savings, but the war (unfortunately in this case) did not last long enough to bring the desired economies and make it a permanent habit. Without a doubt, however, the fact has been established that Government supervision is necessary to prevent wanton waste of fuels. With the end of the war, the emergency governmental supervision was discontinued, and with a lower price of fuel its waste was resumed by consumers.

As to actual conservation the national and state organizations had just started to get into shape for work after the publicity campaign when the war ended and the work more or less slowed down and finally was discontinued, but the field presented a wonderful possibility. A general survey throughout the country showed many steam plants, and particularly small ones, in deplorable condition. In a small manufacturing town in Indiana, after questionnaires had been sent, manufacturers were invited to make use of the technical committee on conservation. Forty or fifty plants were visited. Out of this number only one was found fair, and in the rest a saving of from 10 to 50 per cent could be made without any investment except ordinary common sense. Conditions in other communities were no different. It is the consensus of opinion of those who followed this work that 10 per cent of the nation's fuel bill can easily be saved by intelligent supervision. A small part of this saving would support the work of supervision. Besides this, we are not using all the coal we produce. Some of it is exported to fill the demand not taken care of by other exporting countries.

While coal is not the most desirable article to export, the demand must be satisfied. Foreign manufacturers supplied with cheap labor cannot expect America to provide them with cheap fuel to the detriment of our own industries. Besides, they should expect to pay some of the Government expense for protecting mines as well as the necessary depletion charge for the properties. It would be no more than fair for the Government to charge an export tax in view of the reasons stated, say an amount equal to the cost of production at the mines.

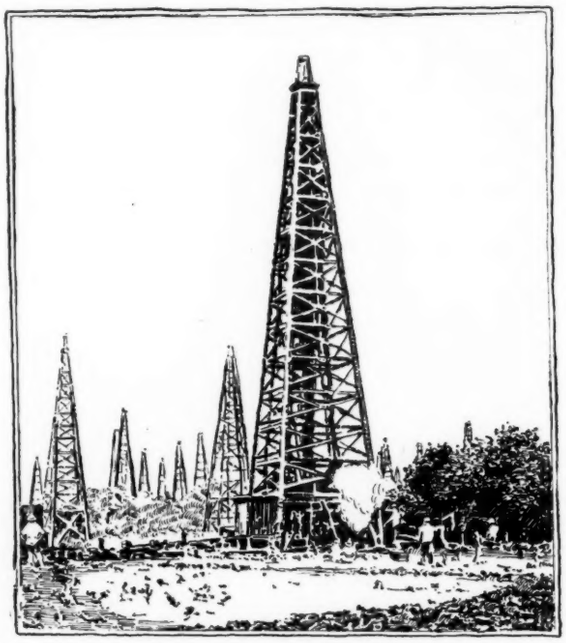


FIG. 2. OIL PRODUCTION AND USE HAVE REACHED MAMMOTH PROPORTIONS, BUT THE BACKBONE OF THE FUEL SUPPLY IS COAL

The World War just ended seems to indicate that militaristic wars are gone, and in the future we will have to face materialistic or dollar wars. To conquer and to hold the world markets, our main advantage is in our supply of fuel. The degree of our success will be in proportion to our ability to conserve. American

standards of living, American influence and power, and in fact our very existence, depend largely on our fuel reserve.

If conservation and supervision of the fuel consumption was required to settle the war in Europe, how much more important it is to conserve our fuel resources when the struggle for supremacy of American ideals depends on the proper utilization of our fuels. Self preservation being the first law of nature, it is necessary that we should use our fuel supply, the mainstay of our greatness, to the best advantage, even at some apparent disadvantage to our friends across the sea. The struggle of ideals and standards of living will take the place of the struggle by force. Constructive effort, which came to us spontaneously in the past and was efficient in our isolation, will not do now in the world-wide competition. It must be organized, co-ordinated and directed to accommodate the new era, and in this fuel conservation stands out in importance.

New Application of Pitot Tube in Testing Pumps

BY ARTHUR L. COLLINS*

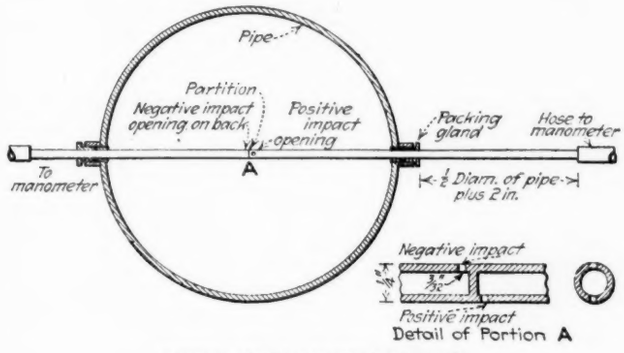
A new application of the pitot-tube principle to the measurement of flow in pipes, which has recently been developed for testing irrigation and reclamation pumping plants in California, eliminates several major disadvantages of the ordinary pitot-tube methods. Although it requires only equipment that can be assembled at low cost, this method can be depended upon for accurate results in the hands of operators not specially trained in testing work.

The development of this method came about through greatly increased rates for electric power in California irrigation districts, immediately followed by a demand for pump tests and careful checks on pump efficiency. To accomplish this it was necessary to have some simple and inexpensive means of determining (1) the quantity of water passing through pipes of various sizes and (2) the head against which the water is delivered. The method has a special field in pump testing because, in addition to measuring volume of discharge, it can be used to determine the direction and velocity in different parts of a scroll casing. However, it is not limited to the pumping field and should prove useful wherever data are desired on the rate and quantity of flow in pipes.

As applied to the needs of the California agricultural districts, the apparatus, as shown in the figure, consists of a tube of small diameter (usually $\frac{1}{4}$ in. to $\frac{7}{16}$ in.) extending entirely through the pipe to be tested. The tube has a diaphragm at its center on opposite sides of which, and facing in opposite direction, are two pitot openings through which the impact of the stream flow, whether positive or negative, registers in two manometer tubes. Thus "upstream" and "downstream" pitot readings can be taken simultaneously. Packing glands are used where the tube passes through the walls of the pipe, and the tube is made of sufficient length so that, by sliding it in the packing glands, the pilot openings can be brought outside the pipe for inspection. Advantages of having the tube extend entirely through the pipe are that there is no vibration or unbalanced pressure due to an "overhung tube," and no danger of injury to pitot openings due to their being accidentally jammed against the far side of the pipe. The device is patented by the author.

With the apparatus set up ready for testing, the tube is slowly revolved until the position giving maximum difference in the manometer columns is noted. When this position has been found, revolving the tube another 180 deg. should reverse the high and low readings on the manometers. This constitutes a check on the accuracy of the instrument and shows at once if the openings are clogged or if air bubbles or other obstructions have lodged in the connecting tubes.

In one typical permanent installation the instrument is being used on a 30-in. pipe. Indicators are installed in this plant on each of five 24-in. centrifugal pumps. The capacity is about 30 cu.ft. per sec., and the differential pressure is 30 in. of water, so that each inch is $3\frac{1}{3}$ per cent of the head, or about 1.6 per cent of the capacity. An operator can read the water columns to within $\frac{1}{8}$ in., so that this variation represents about 0.2 per cent of the capacity; that is, when the capacity of the pump varies 0.2 per cent, the operator can detect the change.



NEW FORM OF PITOT TUBE

With apparatus such as was heretofore ordinarily used for this purpose, such measurements were possible only when conducted by engineers or skilled operators. An advantage of such a permanent installation is that the plant operator at once detects the fall in capacity when sticks lodge in the runner or when the efficiency of the pump is otherwise affected for any reason.

The simplicity of the equipment and methods of test described in the foregoing are such that a complete outfit including everything required for testing pumps of all sizes, ranging from a few inches up to 100 in., and for taking power readings on motors up to 1,000 hp., can be easily loaded into a light auto-truck.

In pumping plants where the efficiency has fallen very low, it is often desirable to ascertain the angle at which the water emerges from the impeller and the velocity in the shell or case, and with these data to redesign and improve the equipment to secure higher efficiency. In both these operations the final degree of accuracy with the testing device described in the foregoing depends only upon the care and pains that the operator is willing to take. The direction of flow is determined by placing a protractor on the end of the pitot tube and then revolving it in a manner similar to that used when measuring velocity. As many as nine tubes have been used for simultaneous readings in measuring velocities in the scroll case of a 42-in. pump.

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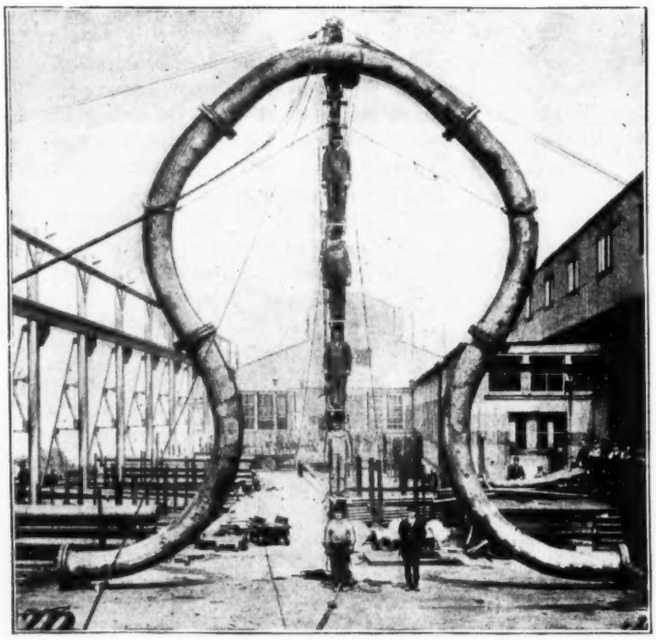
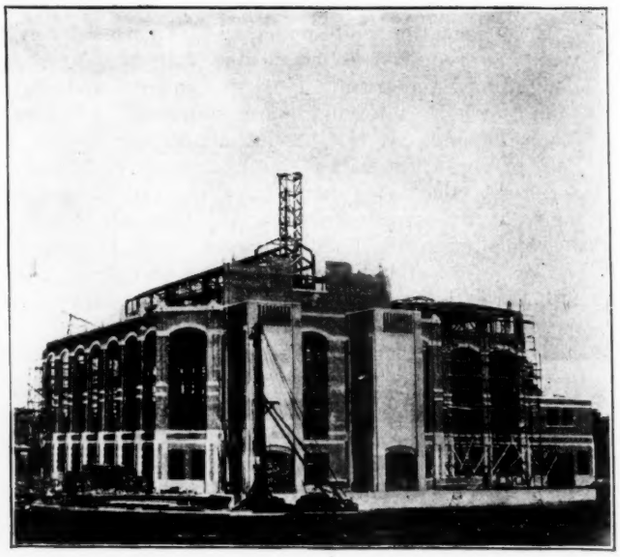
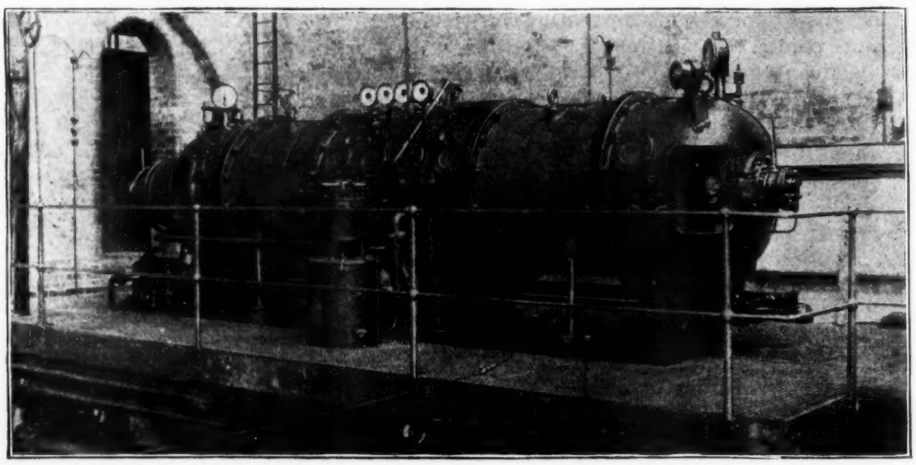


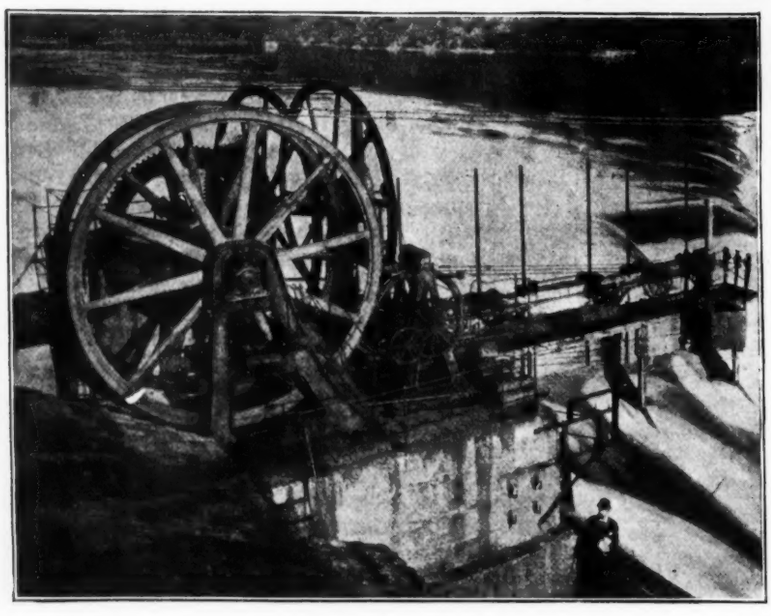
A big fellow—a double offset expansion U-bend that stands approximately 36 ft. high. From face to face of the flanges it measures 37 ft. 7 in. It is made of 24-in. outside-diameter wrought-steel pipe half an inch thick. It was built by the Crane Co. for the Cambria Steel Co.'s plant at Johnstown, Pa., where it is used on a steam line carrying 200 lb. pressure and 150 deg. of superheat.



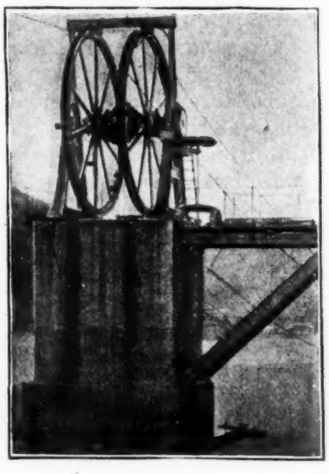
The new Steel Point plant of the United Illuminating Co. at Bridgeport, Conn., being put up by Westcott & Mapes, of New Haven. The ultimate capacity is 100,000 kw., and it is expected that three 10,000-kw. units will be operating about June, 1922.



Right—An example of English turbine construction, a 1,000-kw. machine recently put into operation at a plant in Surrey, England. It is the latest type built by the Brush Electric company and drives the alternator at 3,000 r.p.m., delivering 100-cycle current at 2,200 volts. The exciter is direct-connected, shunt wound. The exhaust goes to a surface condenser.



The queer-looking apparatus shown at the left is the once famous wire-rope drive that carried power across the Rhine at Schaffhausen, Switzerland, from about 1880 to 1900. The plant had a capacity of 700 hp. in three water turbines, one of them supplying power through gears and shafting to a near-by factory and the other two driving the cables. At the right is one of the five pillars over which the cables transmitted power about 500 ft. up the river. The stresses in the ropes were equalized by differentials between the pulleys. Only in 1900 was this inefficient and cumbersome arrangement superseded by three-phase generators connected to vertical-shaft turbines by sets of large bevel gears.



Hydraulic Analogy of an Electric Circuit

The flow of current in an electric circuit is in many respects similar to the flow of liquid in a pipe line. In an electric system a means must be provided for producing a pressure (volts) to cause the current (amperes) to flow. This is just as it is in a hydraulic system—a pressure must be produced, usually measured in pounds per square inch, to cause the liquid to flow, generally measured in gallons. In the electric system the pressure may be developed by a generator or battery, where in a hydraulic system the pressure is developed by a pump.

In one of its simplest forms the electric system may consist of a generator connected to a circuit as indicated in Fig. 1. With the switch open as in the figure, the generator is not supplying any current, and is only producing pressure (volts). This is a condition such as we have in Fig. 2 where a centrifugal pump is used to lift water from a reservoir and deliver it to a water system. With the main valve closed, no water will be supplied into the pipe system when the pump is driven. All that the pump will do is to produce a pressure back of the main valve, which will be indicated on the pressure gage.

If the main valve is opened, as in Fig. 4, then the pump can supply water to the piping system, and if the valves in the branch line are open water will flow. If all five branches are the same size and each will allow 10 gal. per min. to flow, the pump will supply 5×10, or 50 gal. per min. If two of the valves only are open, then the pump will supply 2×10, or 20 gal. per min. When one valve is open, the flow will be reduced to 10 gal. per min., and with all valves closed the flow is reduced to zero.

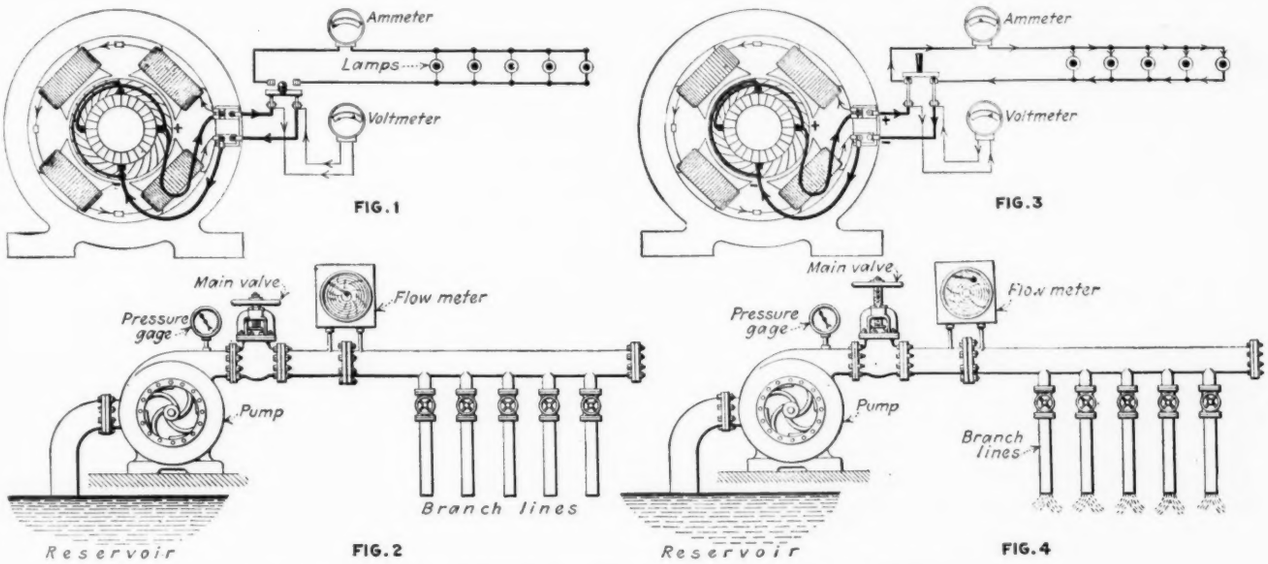
In the electric system, if the switch is closed as in Fig. 3, then the electric pressure will be applied across the terminals of the lamps, and if the circuit is complete through them current will flow. The amount of current flowing will depend on the resistance of the lamps. An ordinary 60-watt 120-volt lamp takes 0.5 ampere. If as in Fig. 3 there are five such lamps, then each lamp will take 0.5 ampere, or a total of $5 \times 0.5 = 2.5$ amperes. This current flows from the + terminal of the generator through the ammeter and lamps back to the — terminal. In this case the ammeter will read 2.5 amperes. If three of the lamps were turned off, then the two remaining lamps would each take 0.5 ampere as before, or a total of $2 \times 0.5 = 1$ ampere, which is the current the generator would supply and what the ammeter would read. If one lamp only is turned on, then the current in the circuit will be 0.5 ampere or that taken by one lamp, and if all lamps are turned off the current will be reduced to zero. This is identical to what we found in the hydraulic system, Fig. 4. With all valves closed, no water would flow and the pump would produce pressure only in the system.

If in the electric system the 60-watt lamps are replaced by 120-watt units, then each lamp will take 1 ampere on a 120-volt circuit. With five of these lamps turned on, as in Fig. 3, the generator will have to supply 5 amperes instead of 2.5.

In Fig. 4, if the small pipe connections are replaced by others having twice the cross-section, the flow will be doubled; that is, 20 gal. per min. will flow through each branch pipe instead of 10 gallons.

In most hydraulic systems the liquid is taken from one location and delivered to another. There are some exceptions to this such as in a brine circulation system in a refrigerating plant. In an electric generator the current that flows from the positive terminal must always return to the negative terminal. The current is not used up in the various devices on the circuit, but is a medium for transmitting the energy supplied to the generator by its prime mover, to the devices connected to the circuit.

In Fig. 5 the pump *A* and water motor *B* are connected together by the two pipes *C* and *D*. If the system is filled with water and the pump driven, the water will be caused to circulate in the system and drive the motor, which in turn may be used to do mechanical work. In this case the water acts as a medium to transmit the energy supplied to the pump by its source of power, to the water motor, just as an electric current



FIGS. 1 TO 4. SIMPLE ELECTRIC SYSTEM COMPARED WITH A HYDRAULIC SYSTEM

acts as a medium to transmit energy supplied to the generator, to a motor or other devices on a circuit. For every gallon flowing from the discharge of the pump in Fig. 5, a gallon must flow into the intake. Likewise for the electric generator, for every ampere flowing from the positive terminal an ampere must flow

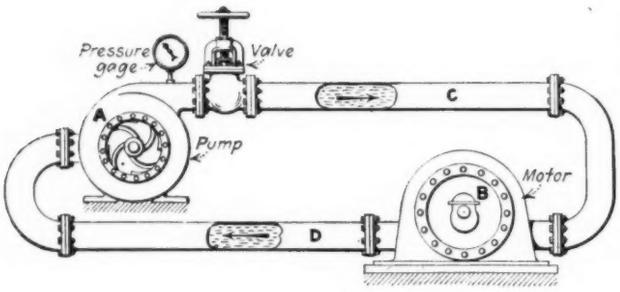


FIG. 5. WATER MOTOR OPERATED BY A PUMP

into the negative terminal. Just as the flow of an electric current is analogous to water flowing in a hydraulic system, so can many other conditions in an electric system be compared to conditions that may be obtained in a water system.

Increasing Water Delivery Through Old Pipe Line

BY A. G. DRURY

A public utility, in addition to its light and power business, supplied several small municipalities with water. It originally had three triplex pumps at a rated capacity of 250 gal. per min. each, driven by direct-current motors.

As the demand for water increased, one of these units was replaced by a 700-gal. per min. centrifugal pump driven by an alternating-current motor. The triplex pumps were old and were constantly giving trouble. The demand for water became such that on wash days it was necessary to run all three pumps to keep up the supply; moreover, owing to an increased direct-current load the voltage was usually so low that the two triplex pumps together seldom gave over 250 gal. per min. The demand increased until it reached approximately 1,000 gal., and a change was necessary. It was desirable to use alternating rather than direct current for operation. Something had to be done immediately to relieve the situation.

The net static lift was 235 ft.; the friction losses in the pump and connections added 15 ft., making a net total head of 250 ft. The company had in its possession a centrifugal pump designed to deliver 500 gal. per min. against a maximum head of 225 ft. This pump was sent to the factory to have a new impeller installed and the casing bored so as to give delivery against a maximum head of 300 ft.; this, however, was accomplished at the expense of cutting down the delivery.

The reconstructed pump was installed so as to deliver into the same discharge pipe as the 700-gal. pump. When the two pumps operated simultaneously, it was found that instead of remedying the trouble the situation was no better, if as good. A test showed that when running singly the large pump would deliver 670 gal. and the reconstructed pump nearly 500 gal. When they operated together, the delivery was 600 gal. from the larger and only 200 from the smaller pump.

The matter was then subjected to a critical analysis. The two pumps discharged into an 8-in. line running 200 ft., which in turn connected to a 10-in. line 5,200 ft. long leading to a standpipe. In the line were five 10-in. ells. By means of tests at different deliveries a curve was plotted showing the delivery against various total heads; the total heads were made up of the net static lift, the friction loss in the pumps and connections and the friction loss in the pipe between the pumphouse and the standpipe. The "total head curve" ran in slightly concave form from a net static lift of 235 ft. at no delivery to 365 ft. at a theoretical delivery of 1,200 gallons.

Next, upon the same sheet the operating characteristics of the pumps, as supplied by the manufacturers, were drawn. Checking back, it was found that the division of the load at 800 gal. per min. was close to what the manufacturers' statements denoted it should be.

From hydraulic tables (published in almost all handbooks) was plotted the theoretical friction head from new pipe corresponding to the old. When superimposed on the net static lift and pump friction curves, this showed a convex curve similar in general form to the actual, extending from 235 ft. at no delivery to 310 ft. at 1,200 gal. delivery, and at 1,000 gal. the head should be 280 ft.; the large pump should deliver 680 gal. and the small one the difference.

Evidently, if the manufacturers' data on the pump characteristics and the hydraulic tables were accurate, the difference between the actual and the theoretical heads was due to excessive pipe friction.

A pipe-cleaning company guaranteed to clean the pipe so that the friction would be no more than 5 per cent greater than that of new pipe. The offer was accepted and after they removed a few blocks of wood, a branch of a tree and several loads of iron rust and sediment from the pipes, a test showed that 1,000 gal. of water could be delivered from the pumps, 640 from the large and 360 from the small one. Needless to say the job was satisfactory.

The result goes to show that when conditions are carefully analyzed and data from reliable manufacturers and engineering tables are applied, results can be predicted with almost certainty.

Automatic 5,000-Kva. Hydro-Electric Generating Station

Preparations are being made by the New England Power Co. to install a 5,000-kva. hydro-electric generating station at Searsburg, Vt., on the Deerfield River. The station will consist of one 5,000-kva., 2,300 volt three-phase 60-cycle generator with direct-connected exciter and automatic control, furnished by the General Electric Co., an I. P. Morris waterwheel, and Woodward governor. The voltage will be stepped up to 72,000 volts through a bank of three 1,667-kva. single-phase transformers and will be tied in with the system of the New England Power Co., which is connected in with other systems and serves a large part of New England. This station will be located in a mountainous, unsettled region, and will be practically inaccessible during a great part of the winter. Maintaining of properly trained and reliable operators under such conditions would prove difficult and expensive.

Automatic control will provide for starting and stop-

ping the unit by means of a time switch. The governor will be given a fairly drooping characteristic, so that the unit will not only deliver approximately constant load, but will assist in regulating the system frequency. In case the water flow is less than that anticipated and provided for by adjustment of the governor, a float switch will shut down the station. While the station is a relatively small portion of the system capacity, it will automatically feed into the system during the part of the day when most needed, but will not draw the pond level down to a point that will use the water inefficiently.

Refrigeration System Gave Trouble

BY A. C. McHUGH

During the summer of 1920, the 15-ton refrigerating plant supplying an institution with ice and refrigeration gave the operating force some trouble. The two-cylinder, single-acting compressor was of the inclosed crankcase splash-lubricated type. The expansion system was divided into two circuits, one supplying a brine tank with a capacity of twenty-four 300-lb. cans, the direct expansion for the ice-storage room, and a 300-gal. water cooler. The other circuit supplied direct expansion for five cold-storage boxes. Each circuit had its own expansion valve, and the temperature of the various rooms was controlled mainly by operating by-pass valves with which the inlet and outlet of each coil was supplied. The operation of the compressor was controlled electrically through an automatic motor compensator by a thermostat in the last of the series of the five rooms. As the expansion valves were of an automatic type, closing with an increase of back pressure, the operation was satisfactory as far as the cold-storage rooms were concerned, but difficulty was experienced with the ice-making end.

The centrifugal brine-circulating pump was small, and consequently the brine circulation in the tank was sluggish. The cans were arranged in four rows of six cans each, with an expansion coil between each row and between the outer rows and the sides of the tank. The outside row of cans on one side of the tank froze much faster than the others, and when pulling these cans were always found frozen to the coils.

As soon as the summer season was over, preparation was made to remedy matters. The brine was removed and stored in the water-cooling tank, ice cans and barrels. Upon examining the expansion coils, it was evident that but two coils of the five were working, owing to the construction of the distributing header. As shown in Fig. 1, the liquid from the expansion valve fed into the first two coils, one on either side of the ½-in. liquid connection, leaving the other coils dry until the first two were filled with liquid, which probably never occurred. To remedy this, the flanges were cut from the header and welded onto short, 90-deg. pipe bends. These were in turn welded into the header. The ½-in. liquid connection was also changed so that when replaced the liquid fed out of the side of the header, thus giving an equal distribution to each coil, as shown in Fig. 2.

As it was shown that considerable oil had been pumped into the system, difficulty having been experienced in maintaining the proper crankcase oil level, it was decided to blow out the brine tank coils. A small air compressor with a 25-gal. receiver was available, steam and air lines were run to the tank and both connected by means of a tee and nipple to a companion flange which was bolted to the expansion-coil flange. Then, with 125-lb. air pressure in the air receiver, the steam was turned on and let blow until all oil and moisture were removed and the coil thoroughly heated. The steam was then shut off and the air valve opened wide, thus removing every particle of steam or condensate. About five gallons of oil and considerable pipe scale were removed from the five coils, the greater part of the oil coming from the first two coils.

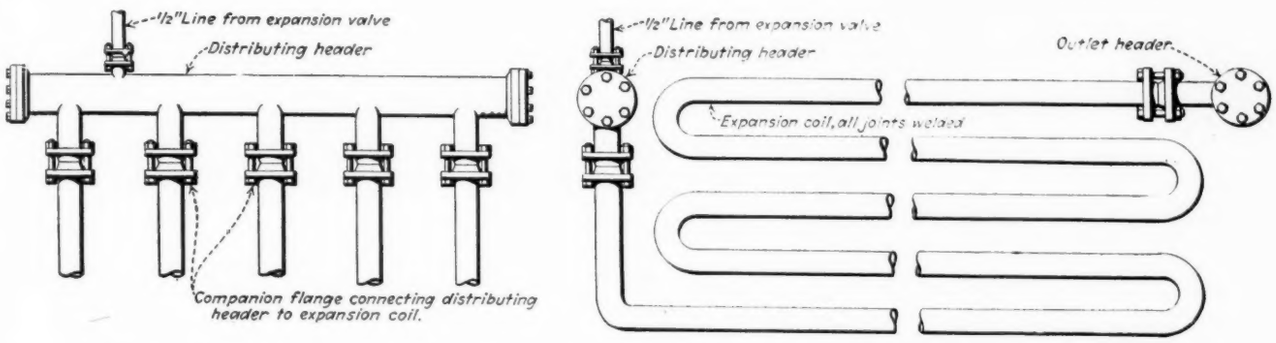


FIG. 1. END AND SIDE VIEW OF ORIGINAL ARRANGEMENT OF DISTRIBUTING HEADER AND COILS

The brine circulating system was next examined. The pump suction was connected to a suction header extending across one end of the tank a few inches under the normal brine level. This header was found partly choked with bits of cork, which had probably fallen into the tank. This, of course, aggravated the sluggish circulation. The discharge was connected to a similar header extending across the other end of the tank about 2 ft. from the bottom. It was decided to drop this header to a point approximately 10 in. from the bottom of the tank. Then the tank was thoroughly cleaned and painted with two coats of graphite paint. A gravity test of the brine showed it to be weak, so enough calcium chloride was added to bring its freezing temperature down to 5 deg. F.

The compressor was next given attention; the valves were ground, bearings taken up, new rings fitted in the lower grooves of each piston, and the upper rings were peened and expanded slightly. The plant has been in operation about nine months since these changes were made, with the result that the ice plant is now working only one-third of the time and it is now possible to fill the ice-storage room, which holds a two months'

supply, in approximately one month of continuous freezing. It is possible to turn out the twenty-four 300-lb. cakes in 5 days with an 18 to 20-lb. back pressure, and still have the machine operating only 12 to 16 hours a day, according to the demands of the cold-storage rooms, whereas the summer before it was a battle to keep enough ice ahead for the daily demand. The compressor uses about 50 per cent as much oil as formerly, and by careful attention practically all this is recovered at the oil tap and receiver drain.

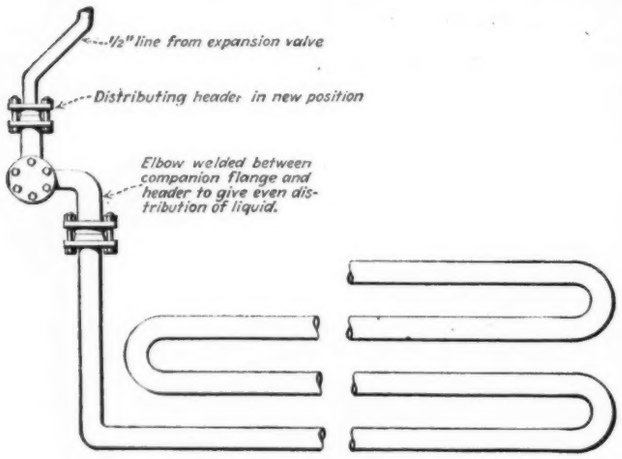

½" line from expansion valve
Distributing header in new position
Elbow welded between companion flange and header to give even distribution of liquid.

FIG. 2. NEW ARRANGEMENT OF HEADER

Excess Air Chart

BY RICHARD BROWN*

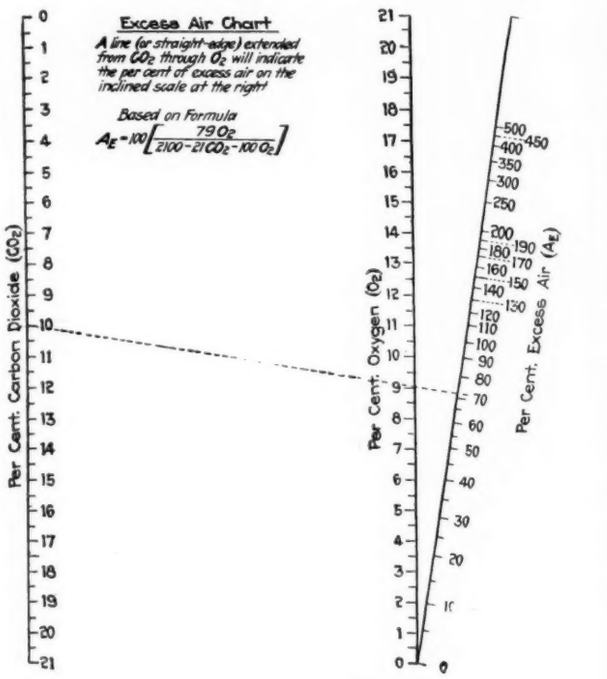
The accompanying chart should be of interest to those who have frequent need to determine the percentage of excess air from the amount of carbon dioxide and oxygen in the flue gas. To use the chart, extend a line from "Per cent Carbon Dioxide" on the left through "Per cent Oxygen" to the inclined scale at the right, which gives excess air expressed as a percentage of the air theoretically required for complete combustion. For example, if the volumetric analysis of the flue gas gives 10 per cent of carbon dioxide and 9 per cent of oxygen, the excess air amounts to 72 per cent, as indicated by the dotted line on the diagram.

On the face of the diagram is shown the formula on which it is based. This formula is strictly correct for any case where there are no combustible elements in the fuel except Carbon and Hydrogen, and where the fuel does not contain inert gases, such as CO_2, as found in blast-furnace gas. The formula and chart give accurate results with coal and fuel oil providing the flue gases are practically free from CO, as is usually the case. Where CO is present in the flue gas, accurate results can be obtained by entering the CO_2 scale of the chart with the sum of the CO_2 and half the CO. This is based on the following formula:

$$A_E = 100\left[\frac{79\,O_2}{2100 - 21\left(CO_2 + \frac{CO}{2}\right) - 100\,O_2}\right]$$

It sometimes happens, on account of errors in the sampling or analysis of flue gas, that impossible percentages of CO_2 and O_2 are obtained. For instance, assume that there is no CO in the flue gas and that the fuel burned consists of nothing but carbon, ash and moisture. The CO_2 and O_2 should total 21 per cent. Since anthracite coal consists almost entirely of carbon, ash and moisture, the O_2 and CO_2 in the flue gas from its combustion should total a little less than 21 per cent. With high-volatile bituminous coals and with fuel oil the sum of the CO_2 and O_2 will be considerably less than 21 per cent because the hydrogen in the fuel burns to water and does not show up in the flue-gas analysis.

Suppose the flue gas from a bituminous coal shows 12 per cent of CO_2, 6 per cent of O_2 and no CO, while that from an anthracite coal shows 12 per cent of CO_2, 8.5 per cent of O_2 and no CO. The percentage of CO_2 is the same in both cases, yet a greater percentage of excess air is being used with the anthracite coal than with the bituminous. The diagram shows 38 per cent excess air for the bituminous coal and 67 per cent for the anthracite. The same percentage of CO_2 would be accompanied by still less O_2 in the case of fuel oil, and hence represent an even smaller amount of excess air. It should therefore be remembered that, in general, the flue gas from high-hydrogen fuels (such as fuel oil and high-volatile coal) should not be expected to run as high in CO_2 as that from anthracite coal.


Excess Air Chart
A line (or straight-edge) extended from CO2 through O2 will indicate the per cent of excess air on the inclined scale at the right
Based on Formula
AE = 100 [79 O2 / 2100 - 21 CO2 - 100 O2]
Per Cent. Carbon Dioxide (CO2)
Per Cent. Oxygen (O2)
Per Cent. Excess Air (AE)

EXCESS-AIR DIAGRAM

Convenient chart for coal, fuel oil and other fuels that contain no combustible elements except carbon and hydrogen, and where the fuel does not contain inert gases such as CO_2. Where there is CO in the flue gas, enter the left-hand scale with the sum of the CO_2 and half the CO.

This diagram also shows clearly that the O_2 in the flue gas comes closer to being a universal measure of the excess air than does the CO_2. Suppose, for example, that with the CO_2 constant at 10 per cent the O_2 is reduced from 10 to 8 per cent. The percentage of excess air drops from 89 to 58. If, on the other hand, the O_2 stays constant at 10 per cent while the CO_2 is reduced from 10 to 8 per cent, the percentage of excess air will change only from 89 to 85.

*Combustion engineer, Worcester Electric Light Co., Worcester, Mass.

EDITORIALS

Commercial Value of Order and Neatness

IN VIEW of the modern habit of reducing arguments to figures and basing decisions thereon, we might appear to be inconsistent in continuing to do certain things that seem at first glance to increase rather than decrease the cost of power. It might be asked, for example, what justification, on a dollars-and-cents basis, there can be for such activities as keeping the engine room well painted or the boiler-room floor swept clean. A similar question might be asked about the time spent in the cleaning and polishing of those surfaces, of engines and other apparatus, that are not vital from the viewpoint of efficient operation and useful life. Again, it may be asked why any money should be spent on appearance in the construction of power buildings and equipment. Is it not the sole function of the power plant to furnish reliable power service at the lowest unit cost? The answer is in the affirmative. Do not all these activities and expenses tend to increase the cost of power rather than decrease it? No general answer can be given to this question. It all depends on the circumstances of the individual case. Certainly, it is true that these things can be overdone. There is probably real wisdom back of the change that has done away with much of the ornamentation and the profusion of polished surfaces that characterized the steam engines of earlier days. No modern builder advertises, as did one in the middle of the last century, that his engines are of "Chaste Gothic Design." The style of architecture does not cut much figure nowadays when it comes to selecting an engine.

There is a certain "golden mean" in this matter of the expenditure of time and money for things that do not contribute directly to the making of power. The only defensible reason for such expenditures is the favorable effect that they have on the men who run the plant and thus, ultimately, on the plant itself.

From one point of view man is a machine, but he differs greatly from most of the machines with which he deals. For instance, his actions are decidedly influenced by what he sees and hears. To an astonishing extent he rises or falls to the level of his surroundings. A coat of paint on the engine-room walls, a clean desk for the engineer or an orderly arrangement of the operating records may have no conceivable *direct* effect on the machinery of the plant but their indirect effect may be of considerable importance.

These things give delight to the eye and build up pride. They advertise the men to themselves as people who do things "up to the handle." Like most advertising this is effective and goes a long way toward making them, in fact, what they appear on the surface to be. The mind that is freed from the confusion caused by needless dirt and disorder is more likely to reach out for new fields to conquer. It is less likely to overlook leaky joints and improperly adjusted pieces of equipment.

So cleanliness and order have a commercial value as long as they are made a means to the end of improving plant operation and as long as the expenditure is not carried to the point where the results obtained are not worth the cost. The fundamental principle is the same as that of any investment but the values involved are too elusive to be expressed in figures, so the proper allowances must be made by judgment. If we could figure the advantage, we would. Since we cannot figure it, we merely show our good sense when we appreciate and act upon the fact that these things do have some value.

A Cautious Recommendation

RATING electrical motors on a fifty-degrees-rise basis rather than forty degrees has been the cause of a great deal of discussion both for and against the higher rating. In general the motor users have not been very enthusiastic for adopting the fifty-degrees-rise motor. The steel industry is not only one of the largest users of motors, but these applications are among the most severe on equipment, therefore the recommendations for motors in this service by those who have to keep them running is of more than passing interest. At the recent convention of the Association of Iron and Steel Electrical Engineers the standardization subcommittee on motors in its report recommends the forty-degree rating for direct-current motors used in auxiliary service, insulated with fibrous insulation (known as class "A" insulation). For alternating-current motor use in auxiliary service the fifty-degree rating is recommended, but with the forty-degree rating given on the nameplate. From a careful study of this report it would appear that the committee has not sanctioned the operation of motors at fifty degrees rise, but has made the recommendation with the purpose in mind of obtaining a more satisfactory forty-degree rise motor.

After outlining the reasons for recommending this rating, the report says: "The user then has only to determine what load will be imposed on the motor and apply the next largest size. If he is afraid that this knowledge of load conditions is at fault and wants to place a factor of safety in the motor, he merely takes a size or two larger motor instead of taking a motor with a low temperature rating and carrying the factor of safety in the overload capacity of the motor." This evidently is a recommendation to load the motor so as to operate it at the lower rating.

In either the higher or lower rating the maximum torque of the motor is taken as two hundred and fifty per cent of the full-load torque. This being the case in either the forty- or the fifty-degree rating, a given amount of material will give a higher torque in the high-temperature rated motor. If this motor has its bearings, shaft and frame designed for the higher horsepower output, then when it is operated at the lower temperature rating the motor will not only have the mechanical strength of a machine at the higher rating, but also the starting and pull-out torque ratings. In other words, when a motor designed for a fifty-degree rise is applied to a load that will cause only

forty degrees rise, it becomes a machine of a superior design to the present forty-degree machine.

In the direct-current motor the torque is not limited as in the alternating-current machine, therefore the advantages of the high ratings with the former are not so evident as with the latter. This is one of the influencing factors in recommending the forty-degree rating for this class of machine. Commutation must always be kept in mind when applying direct-current motors. If the temperature at the brushes and commutator becomes very high, it is difficult to prevent serious trouble. Brushes lose their lubricating qualities and then cutting and sparking result.

If the fifty-degree-rise motor is as reliable and satisfactory as the forty-degree-rise machine, as is claimed by a number of the manufacturers, the two ratings on the nameplate will undoubtedly lead to the general adoption of the higher. Although users of these machines may be skeptical at first and may load them for the forty-degree rating only, they will gradually find that just as reliable service can be obtained from the machine at fifty-degree rise, which will remove the present prejudice.

Emergency Employment Plans

AFTER an interval of ten days the Unemployment Conference is again in session at Washington. Its first session dealt with measures for temporary relief; the second will consider means of preventing recurrence of present conditions. The intervening period was employed in an attempt to get the emergency measures started and in further consideration of the facts collected.

This conference is in marked contrast to those of the past in that it has functioned on a strictly business-like basis with a definite plan. Prior to its opening, statistics had been collected by trained investigators; plans that had previously failed were listed; and a well thought-out program had been arranged. Consequently, within five hours after President Harding's opening address the committees had been appointed and were functioning with the aid of advance data. This may be regarded as a tribute to the organizing ability of Mr. Hoover and his assistants.

It was deemed most effective and expeditious to attack the unemployment problem through the local communities with the idea of getting public construction, repairs, alterations, etc., started at once. This, in turn, would react to stimulate the various industries supplying materials. It was roughly estimated that nearly two million people could thus be employed. Supplemental to this are plans, to which a number of manufacturers have already agreed, providing part time and rotational employment, as well as manufacturing for stock.

The emergency measures recommended are not to be regarded as a panacea, but rather the most logical means of organizing the country by getting something started and provide, at least, partial relief. However, the solution of the problem will be effective only in so far as the recommendations are carried out with a spirit of patriotism on the part of all the people.

In this connection there is an opportunity for the power-plant field to do its share. Many needed repairs, replacements and extensions can be made and advantage taken of present favorable prices in many lines of equipment.

The country will look forward with anticipation to the recommendations of the second session of the conference, looking toward a permanent solution. Unfortunately, we do not have enough Henry Fords in the industries and too many industries are still guided by the hands of the banker rather than the business man. To get things started, many will have to be prepared to assume losses on materials purchased at inflated values and count on making this up through increased volume of business at smaller unit profits.

Co-operation and Development

THE development of machinery results, to a large degree, either from research or from operating results and experience. The latter is, or should be, a most important factor. Most manufacturers endeavor to keep in touch with operating results, either through salesmen or through field engineers. This attempt is praiseworthy so far as it goes. It is obviously impossible, however, that occasional visits of inquiry can give as intimate knowledge of performance as every-day usage. The user is in best position to know the possibilities and shortcomings of the apparatus in his charge. Oftentimes he rectifies faults or develops small improvements on his own initiative without recourse to the manufacturer.

Some of the engineering associations accomplish in their respective fields, a close relation between manufacturer and user through the intermediary of joint committees and annual reports. The results of this co-operative effort are most commendable. This work is naturally confined to specific interests and practices. In many other fields a like degree of co-operation should result in expediting development and directing it along the most beneficial and useful channels. Other organizations may well study and emulate the methods of those societies that have already established a plan of co-operation between the users of equipment and the manufacturers.

The Government itself is accused of contributing to the present unemployment situation in a statement from Luther C. Steward, president of the National Federation of Federal Employees, which was laid before one of the committees at the Unemployment Conference in Washington. "The Government itself, without intelligent planning, without discrimination, without even the humane consideration of so much as one day's notice, has thrown thousands of men and women into the ranks of the unemployed, and spread the psychology of industrial unrest," in the words of Mr. Steward. He takes the position that politicians have in many cases gained office on the basis of promises to cut down expenses, and that now, in order to save their faces, they are wielding the ax right and left with that stupidity and lack of foresight which is, unfortunately, all too characteristic of Government enterprises. He points out that all the civil expenses of the Government amount to but seven per cent of the whole and that, therefore, a tremendous cut in the payroll of civil employees represents an almost insignificant saving. Economy needs no defense in these times, but practices such as these are not economy, and it is to be hoped that some action will be taken to prevent official hypocrisy from causing so great a degree of economic waste and human suffering.

CORRESPONDENCE

Good Results with Metallic Packing

An engineer of broad experience has had some interesting experiences using nine different makes of metallic packing—so-called shredded packings, molded rings, etc.—on sea and land, for both high and low pressures, and as his experience covers placing metallic packing on new rods and also its installation some weeks later, after the rods have become somewhat glazed, he states that he has had greater success by placing the metallic packing on the new rods and letting them get "broken in" together.

On two locomotives the rods were old, but they were turned down true and ground on centers, highly polished and then the packing was applied. Soft gray cast-iron packing rings seem to have given the best and longest service. The cylinder openings were bushed with a babbitt ring and given but $\frac{1}{64}$-in. clearance; if the guides are properly adjusted to prevent the lifting and dropping of the piston rod, the cast-iron rings will glaze the rod nicely, and if proper lubrication is applied constantly, no leakage will take place and the wear on the rod and packing will be negligible during several years of operation.

If the packing starts blowing at times, it indicates that grit or scale has wedged between some of the rings. It is advisable to remove the packing rings and clean them properly. But all the rings must be replaced in the same relative positions they occupied previously. It is easy to mark each ring as they are removed, or set them on a bench in the relative positions that they occupied in the stuffing box.

Hard babbitt rings give excellent service. They have the advantage that even though lubrication is forgotten for a few hours, no harm results, which is not the case with gray cast-iron rings. The latter will start cutting and there is danger of scoring the rod.

Constant lubrication, not necessarily copious lubrication, is needed. Fine results may be had with three drops of cylinder oil per minute on a 4-in. diameter rod with gray cast-iron rings with 640-ft. piston speed per minute. Oil was compounded for wet steam and it clung to the rod and gave fine service on 1,200 lb. air down to 800 lb. on three-stage compressors. The cast-iron rings gave better service than babbitt rings; the latter wearing too fast and leaking after fourteen months' service. Thirty-four months' service was had with cast-iron rings and no leakage to speak of.

Cast-iron rings must be scraped to fit, and no halfway measures will go. A mandrel turned and ground true to the same diameter as the rod to be fitted, and turning this mandrel at high speed in a lathe and using pumice and water to grind in the metallic packing rings, gives the finest of results quickly.

As to using an oil cup and dropping cylinder oil on the piston rods, using fibrous packing, I have saved an average of three packings a year on each of four Corliss engines, a total saving of fully $50.

This engineer uses oil cups on pump rods and gets less friction, and the packing does not get hard until after long service. The packing always has lasted longer and only two or three drops a minute is used. Oil the piston rods using any kind of fibrous packing; a compound oil gives the best service on steam rods, and a straight mineral oil on air and ammonia-compressor rods with either metallic or fibrous packing.

Waynesboro, Va. F. H. SWEET.

Cleaning Inspirator Tubes Produced Different Results

I had an interesting, if not an understandable, experience recently. In my plant there is a small boiler that is fed by a simplex pump, and an inspirator is used as an auxiliary feed at times. Down the street is another factory, in which the boiler is fed by the same kind of an inspirator.

One day the engineer of this plant dropped in and wanted to know why his inspirator would not feed. To test out his pipes, the inspirator in my plant was detached and connected up in the other plant. On testing, the inspirator started up and worked all right. We then tried the one that belonged in the plant, but it would not work which showed that the trouble was in the inspirator itself. The workable inspirator was reconnected so as to keep the boiler in operation, and the other one was taken back to my plant for repairing, if possible.

An examination showed that the tubes were somewhat scaled, and a drill of the proper size was run through them. When the inspirator was connected up, it operated as if it were new.

In my plant there was a spare inspirator of the same size as the one that had been made to work, but it could not be made to force the water into the boiler. As the tubes looked as if they were scaled somewhat, the same drill was used to clean them out, the idea being that if it worked with one instrument it should with the other. But it did not. When the second instrument was connected in place, it failed to pick up and has never worked since. Why did cleaning the tube of one inspirator cure the trouble and fail to do it in the case of the other one? G. A. EMMONS.

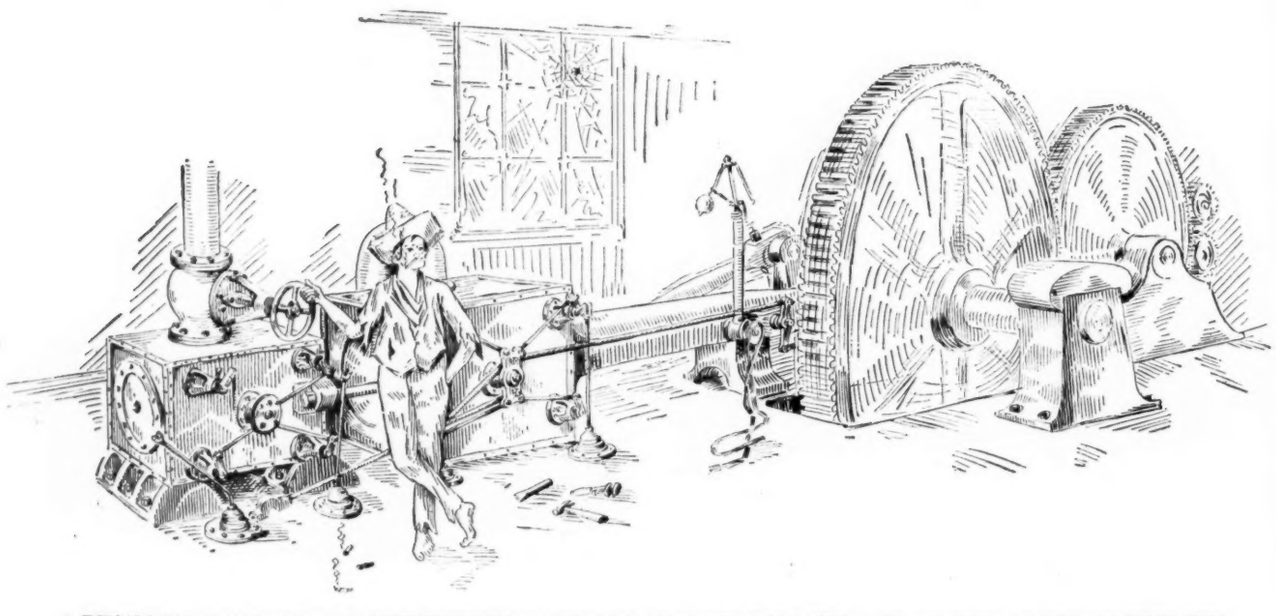
Buffalo, N. Y.

An Engineering Experience in Mexico

In spite of exasperations, discomforts and even dangers, we old timers in Mexico get a good deal of amusement once in a while out of things that we run across. Some little time ago a young engineer, who has to do with sugar mills down toward Colima, asked me to drop in and take a look at a Corliss engine at one of the haciendas. He is a young engineer and knows more about chemistry than about Corliss. In spite of the fact that his boss is an A. S. M. E. member, he has a reluctant suspicion that their joint efforts to improve the adjustment of the valves of this engine were not wholly successful. In due course I made the journey out to the hacienda and took a look at the engine.

It was enough to make the angels weep. This poor old veteran, a tandem-compound Corliss of an early epoch, had faithfully ground cane for twenty-five years running for years without fouling the valve-motion brackets I do not know, but after breaking one off the cylinder, when trying to turn the engine over, he proceeded to chip in each of the survivors a clearance for the valve-motion arms. This triumphantly effected, he made the interesting discovery that by the aid of a full supply of live steam to the low-pressure cylinder with the high-pressure cylinder cut out, and a peon at the throttle in lieu of the governor, a notable increase of power could be developed by the use of a full boiler pressure and steam admission for the full length of stroke—as long as the engine would last, anyhow.

These triumphs of steam engineering were accomplished at last, after heartbreaking labors of all hands and the cook, for it is no trifling thing to turn a heavy Corliss engine over by hand every time a completely rattled chief wants to see what will happen in the way of valve movement, if the engine is put on the opposite



A PEON WAS STATIONED AT THE THROTTLE AND THE ENGINE GROANED AND LIMPED ALONG TO THE END OF THE GRINDING SEASON

or more, and now in its defenceless old age met its Waterloo. It had survived the ministrations of generations of Mexican mechanics, had been lubricated with lard or nothing, the functions of its dashpots had never been understood and were now forgotten, and the governor had long been a respected ornament.

But with the arrival of the A. S. M. E. engineer and his young but ambitious assistant, all this was to be changed. The first thing to do to a Corliss engine under any circumstances is of course to set the valves. Now this is simple enough if you go at it right; if you don't infinite possibilities are opened and strange results are to be expected. And they got them. They lengthened the reach rods between the wristplate and the valve-motion arms until these arms fouled the bonnets. This was a facer, but the Big Chief decided that it was conclusive evidence that the throw of the eccentric was too great. Even to him this appeared a bit strange, but by a brilliant flash of inspiration he saw at once that the eccentric did not belong to this engine originally, but had been picked up in a junk shop. How he accounted for the fact that the engine had been center. But there is an end to all things, so at last the old veteran, shorn of high-pressure cylinder, innocent of cutoff and goaded to action by a brutal peon at the throttle, groaned and limped along to the end of the grinding season.

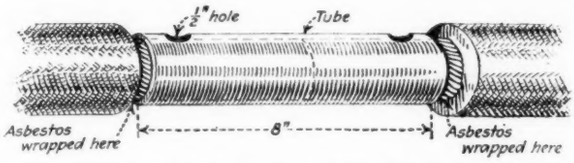
This sounds like a flight of fiction, but it is tragic fact. When I examined the poor old victim, I found every dashpot useless, the cushion valves hidden and forgotten below crusted grease and dirt, stiff cup-grease in the dashpot of the governor (no wonder it would not work) and the valves in a hideous state of maladjustment. I have in the course of a long and varied career seen many sad cases, but this brought tears to my eyes —from laughing—as I stood by this faithful old worker, saw the condition it was in, and heard the tragic story of its shame from the lips of the young but doubting engineer who was accomplice to the chief.

So, although we get up in the morning here and put on our six-shooters with the scanty balance of our clothes, shake the scorpions out of our shoes and proceed to the normal daily troubles, we have gleams of fun too

Los Reyes, Mexico. G. H. KEYS.

Quick Repair of Burnt-Out Cables

Recently, a severe burn-out occurred on the main cables from a bank of transformers to a switchboard in a large paper mill. The cables consisted of six 2,000,000-circ.mil conductors, two in parallel for each



METHOD OF MAKING CABLE SPLICE

of the three phases. These cables were run through a duct to the switchboard. The burn-out occurred during a severe electrical storm, but it was not determined whether the failure was caused by lightning or from water getting in the duct and causing a short-circuit of the cables, which were burnt and run together for three or four feet.

It was important to get these cables spliced as soon as possible. My practice has been to splice all large cables by soldering on lugs and bolting them together. Lugs were not available for this job, so some brass tubing about ⅛ in. thick and 8 in. long was obtained. I tinned the tubing on the inside and also tinned the cables. A ½-in. hole, one inch from each end was drilled through the top side of the tubing to pour in the solder. The sleeves were slipped on and the cable ends butted together as in the figure. Solder was then poured in until it ran out freely, indicating that the cable was hot. Asbestos was wrapped around each end of the sleeve, which was afterward filled with solder and allowed to cool before further handling of the cable. Then the joint was taped, making a neat-looking splice not any larger than the cable, which has been carrying an overload for three months without any signs of heating.

MARIN PHILLIPS.

South Kankauna, Wis.

An Early Steam Turbine

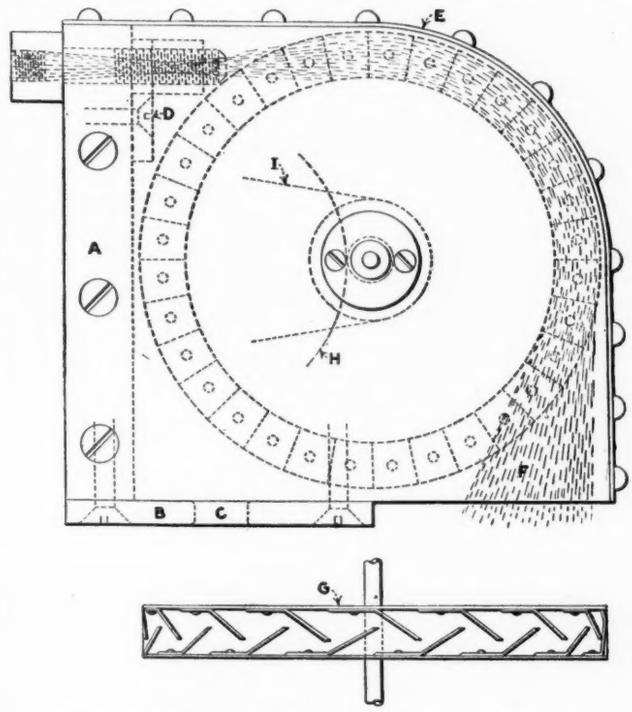
It is a question in my mind as to when, where, by whom and how the application of steam direct to a rotor was first used. I was aware in 1860 of a rotor driven by air, and this occurrence gave me the idea to use steam because I had access to plenty of it.

My steam wheel, as it was called, was made in part at Heap's plumbing shop in Kent Lane, Kendal, England, and at the Castle Mills machine shop of the same town. It was an incased impulse wheel mounted on a light spindle and with interchangeable nozzles. The case was made of one cross-piece *A* and two side pieces of wood, beeswaxed with a hot iron at the organ factory of William Wilkinson & Son, and fastened together by brass screws. A base plate *B* extended out on the sides, having bolt holes *C*, and made a part of the case *D* is the nozzle holder, secured to the cross-piece *A* and tapped to receive the nozzle. This nozzle, of which I had three, was copied from a fireman's hand-pump hose nozzle so far as the tapers are concerned. *E* is a piece of sheet brass secured to the end pieces making the opening. *F* is for exhaust and *G* is the wheel made in part at the Castle Mills machine shop and Heap's plumbing shop. *H* is the pitch line of the gearing to reduce the speed and *I* that of a cord over grooved pulleys. The gearing was on one side and the grooved pulley on the other to hold the wheel central; the spindle was in tight.

The wheel was often experimented with by my elders during my trip to London in 1862, when visiting the World's Exposition. After my return I found myself the possessor of a steam boiler, but I had more trouble making steam than using it. On one occasion, using liquid fuel, I fixed up a huckster's naphtha lamp under my boiler, and with the wheel geared down to a windlass all was installed in a boat ready for a trip.

Failing in repeated attempts to drive my boat across the millpond by its own power, it was taken to the other side, a line tied to it and the other end connected to the windlass. It was then towed across amid cheers. It was great sport for us boys, and we had no idea that we perhaps were making a world's record in steam engineering, yet we all felt like experts. That boat eventually went across the pond under its own power without any line attached to it, and this achievement soon sold it.

A short time after this I left for the United States, arriving in Rochester, N. Y., in 1864, and in that year



SHOWING DESIGN OF ROTOR AND THE PATH OF STEAM THROUGH TURBINE

I tried to interest John Greenwood, J. B. Dougherty, D. A. Woodbury and Julius Judson in my new theory of how to use steam, but they were only amused at my persistence.

Years after, at the Centennial Exhibition in Philadelphia, I hoped to see something in my way of thinking, but found nothing. It was in the following year, 1877, that I made the acquaintance of David H. Burrell, of Little Falls, N. Y., in other lines of work, and to him I submitted my drawings and was soon under a written agreement with his firm. At this time the mechanical separation of cream from milk had started in Europe and was being introduced into the United

States. The idea was advanced at Little Falls, N. Y., to use my steam rotor instead of a belt on the machines, for at that early day I insisted that the smaller the bowl, with the same periphery speed, the greater the efficiency.

D. H. Burrell & Co. advised that I keep quiet about all this, but I did not. I started, independently, in 1887, to design a wheel that could be used for water if my steam theories should fail. In Poughkeepsie, N. Y., at the works of the Polk Foundry and Machine Co., my machine was built and tested by them and paid for. It was then installed at the pottery works of Adam Caire to run as an exhaust-steam turbine, taking steam from a high-pressure slide-valve engine and operating non-condensing. This turbine ran all of the potter's wheels it could do easily, but for good reasons the potters did not like the steady speed and I had to remove the installation.

I then made a series of water tests and, when satisfield, shipped the machine to my home address in Little Falls, and then went to the office of D. H. Burrell & Co. to argue my troubles with them. The result was a reshipment of the machine to run as a water motor.

Soon after this I saw in Little Falls a cream separator to be driven by steam, and in a most disgusted state of mind went to Buffalo to our attorneys and raised my protest. Then I went to Poughkeepsie, calling on William Lane, and made a bid to buy his patent. He gave me the sole right to use it for steam only, but would not sell for preventing any case of infringement. My friends dissuaded any contest of my rights, and I soon afterward went into reciprocating-engine work, recommending turbines only for the power processes.

As a matter of interest to myself, I filed an application for patent on a motor embodying the principle I used so long ago to cover some improvements which I considered of value in an explosive machine and also to ascertain from the official searches just where the state of the art was and is.

I feel that I have been amply repaid by the knowledge gained of what has been done both here and especially abroad and also to know that I found nothing prior to 1860. JAMES NAYLOR.

Arlington, N. J.

[The first steam-turbine patent issued in the United States was to Foster & Avery, in 1831. The Leroy turbine dates back to 1838, the Pelbrow to 1842, the Wilson to 1848, the Delonchant and the Tournaire both 1853 and the Hartman to 1858. The Real and Pichon turbine dates back to 1827.—Editor.]

Repairing a Leaky Steel Feed-Water Tank

In the pumproom in one of our plants was a steel tank that was used as a hotwell. This tank was approximately 12 ft. wide, 30 ft. long and about 9 ft. high and was made of sectional plates $\frac{3}{8}$ in. thick, riveted together. The bottom of the tank was supported overhead by means of a steel structure.

This tank had been giving considerable trouble for some time, because of a leak in one of the joints in the underside, in consequence of which the floor of the pumproom was always in a wet and unsightly condition.

On close examination it was found that there were several rivets loose in one of the joints. It was decided to make a temporary shift of the pump suctions while the tank was undergoing repairs. A couple of boilermakers were summoned to repair the tank, and they chipped out the loose rivets on the seam that had been giving trouble and after they had driven in the new ones, we again put the tank into service. Much to our disgust new leaks had developed, and the tank leaked more than ever. The pump suctions were again changed and the tank emptied.

A saturated solution of water and sal ammoniac was then prepared and well applied to every joint from the inside of the tank by means of a brush. This performance was repeated for three consecutive days, after which the tank was again put into service and was found to be watertight; the action of the sal ammoniac had rusted the joints together, thereby making them watertight.

This trouble happened about two years ago, and the tank is still as good as ever. The only thing done to it since was the application of a coat of red lead over the joints, recently, while the plant had a shutdown. I have had occasion to make use of this same stunt on several other tanks with good results.

Brooklyn, N. Y. H. BLOMGREN.

Emptying Barrels with Compressed Air

In the Aug. 16 issue Mr. McNulty describes a device for emptying barrels by air pressure. An essential element of such an apparatus is some means of limiting the pressure to which the barrel will be subjected. Even with a low lift an oil of high viscosity is extremely likely to give the user of such a device a messy lesson in elementary hydrostatics unless the pressure is carefully limited.

The most efficient method of limiting the pressure is to use a small pop valve set to about two to three pounds per square inch with a noisy whistle attached to the outlet. The air inlet to the barrel should be very small; about one-eighth inch is sufficient. Many oils increase in viscosity as their temperature decreases, so that a device of this kind becomes dangerous in winter if the oil barrels are stored in the yard. When properly used, this apparatus is extremely serviceable. Compressed air is widely used in a similar manner for pumping acids and other corrosive fluids that cannot be handled by pumps.

Newark, N. J. A. D. WILLIAMS.

Lengthening and Shortening Corliss Governor-Valve Rods

Two engineers recently got into an argument regarding the effect of lengthening the long and shortening the short rod on the governor of a Corliss engine. One maintained that is would lengthen the point of cutoff and that the governor would rise to a higher plane with the same steam pressure and the same load.

The other contended that such a procedure would not lengthen the point of cutoff. He maintained that to lengthen the long rod and shorten the short one would lengthen the point of cutoff, and that with the same load the governor would rise to a higher plane, but to do so the engine would have to run faster and that this would require a later cutoff. Which engineer was right? P. A. UPHAM.

Columbus, Ohio.

INQUIRIES OF GENERAL INTEREST

Protecting Handhole Bolts and Gaskets from Burning—How can we prevent burning out of gaskets and guard bolts of rear handhole plates of our return-tubular boilers? G. M.

Under ordinary conditions of firing return-tubular boilers, handhole gaskets, guards and bolts can be prevented from becoming burned by having the handhole-plate guard and bolt protected with a thick covering of asbestos cement.

Cylinder Lubricating Oil For Diesel Engine—How much lubricating oil should be fed to the cylinders of a Diesel Engine? R. G. M.

The amount depends upon the condition of the engine. If the cylinders are not worn, sufficient oil should be supplied to make a thin film on the walls. If a single ordinary cigarette paper, when placed on the cylinder wall, shows oil soaking through the paper, the supply is about right. If the piston and cylinder are worn a greater supply must be furnished.

Reducing Slippage of Oil-Soaked Governor Belt—What is the best way to remove oil from a leather governor belt to reduce slippage, using the equipment available in an ordinary power plant? A. D. F.

Much of the oil near the surface of the leather can be removed by laying the belt, when warm, on a flat suface and then, with the belt liberally sprinkled with most any dry powdered substance not injurious to leather, such as ground whiting, powdered chalk, flour or fine dry sawdust, scraping the belt surfaces with hard pressure on a thin scraper that is about 1 in. wide with edges and corners rounded like a worn putty knife. The scraping should be done in a direction to rub down rather than turn up the laps of joints in the belt. After several such operations, repeat at intervals of a few hours. After the belt has been cleaned, a coating of castor oil will be serviceable for increasing its adhesiveness to the pulleys and for protecting it from impregnation by lubricating oils used about the engine.

Charge of Static Electricity Produced by Steam Leak—A leak in one of the steam lines in a small plant was found to have the peculiar property of charging the whole steam piping with static electricity. Anyone holding one hand in the jet of escaping steam could draw a spark ¾ in. long from any other part of the piping and receive a severe shock, providing he stood on a ladder or wooden board insulating his body from the ground. How is this charge produced, and how can it accumulate on the piping system when the latter is grounded through the feed-water system, the boiler and many other points that are more or less directly connected to the ground? There is no electrical apparatus or wiring on the premises. C. H. D.

Wet steam escaping through a small orifice at high velocity has the property of producing a static charge by the friction of the small globules of water contained in the steam on the wall of the orifice, just as a charge may be produced by rubbing a stick of amber or hard rubber, or the fur on a cat's back. In the foregoing case, however, the charge on the steam pipe is only apparent, as any charge produced leaks off at once to the ground. The explanation is as follows: The escaping steam charges the piping negatively, but itself positively. The negative charge on the piping escapes, but anyone coming in contact with the steam jet become charged positively, provided his body is insulated from the ground. The spark drawn from the piping is due to the escape of this charge to the ground through the piping system, and not to any charge on the latter.

Loss From Ammonia Discharge Pressure Drop—If the discharge line in a refrigerating plant is so long that the compressor pressure must be 180 lb. gage to give 140 lb. gage pressure at the condenser, is there any direct loss? The suction pressure is 30 lb. gage and the temperature is 0 degrees F. R. N. G.

Assuming that the suction vapor comes to the compressor saturated, the discharge temperature at 180 lb. pressure would be 290 deg. The suction vapor would have 550 B.t.u. per pound, and after compression to 180 lb. gage and 290 deg. temperature, the vapor would contain 667 B.t.u., or the work done in compressing is 127 B.t.u. By reducing the length of the discharge line or by increasing its size, the discharge pressure could be made approximately the same as the condenser pressure, 145 lb. gage. The discharge would now contain 650 instead of 667 B.t.u., a net gain of 17 B.t.u., or approximately a reduction of 15 per cent of the work of the compressor.

Greater Steam Consumption for High Back Pressure—Our 16 x 42-in. Corliss engine is run at 70 r.p.m. with an average load of 110 i. hp., and the steam consumption is estimated to be 32 lb. per hp.-hr. What would be the increased steam consumption if for supplying exhaust steam to a heating apparatus it becomes necessary to increase the back pressure 3 lb.? S. K.

In considering the effect that a variation of back pressure has on the amount of steam that must be supplied for a given load, it should be borne in mind that development of the same indicated horsepower will require the same m.e.p.; also that for each additional pound of back pressure, taken as an average of pressure during the whole exhaust stroke, there must be an additional pound of average forward pressure during the stroke of admission and expansion. For a few pounds increase only of the mean effective pressure, the average forward pressure and the steam consumption would be increased in about the same proportion; and for all practical purposes it may be assumed that with the same load the increased steam consumption per additional pound of average back pressure will be the same as though the increase had been made in the mean effective pressure.

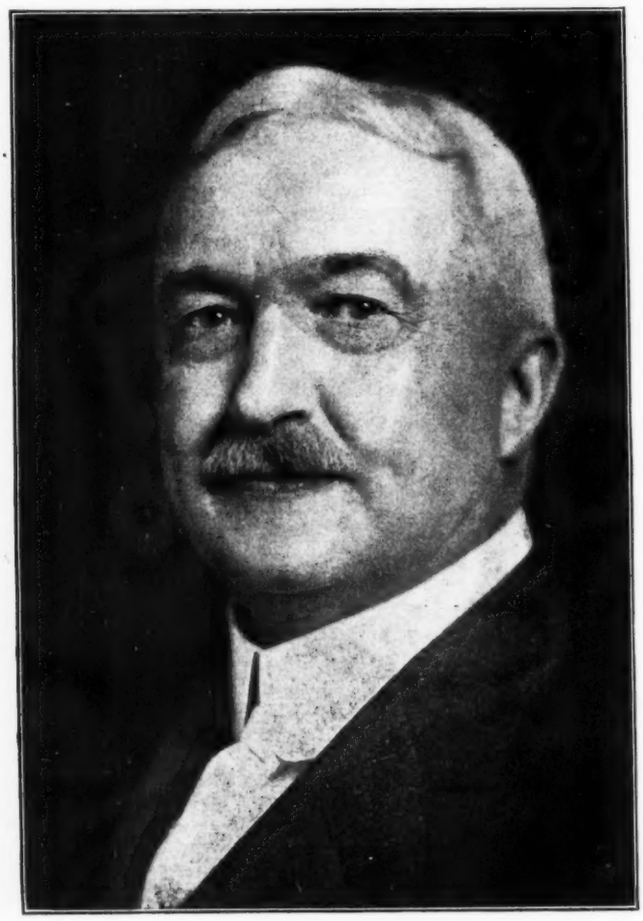
Neglecting the displacement of the piston rod, the horsepower constant, or indicated horsepower developed per pound

$$\text{m.e.p.} = \frac{16 \times 16 \times 0.7854 \times 42 \times 2 \times 70}{12 \times 33{,}000} = 2.9854 \text{ i. hp.}$$

The average load of 110 i. hp. requires $110 \div 2.9854 = 36.85$ lb. m.e.p., and with 3 lb. additional average back pressure the engine would require $\frac{3}{36.85} = 8.14$ per cent more steam for the same load. Assuming the present steam consumption to be $110 \times 32 = 3{,}520$ lb. per hour, the additional steam required would be $3{,}520 \times 0.0814 = 286.5$ lb. per hour.

Cooley Made Head of F. A. E. S. at Council Meeting

The outstanding feature of the meeting in Washington on Sept. 30 of the executive board of the Federated American Engineering Societies was the willingness with which those in attendance discounted the obstacles that have arisen and their evident determination to make the organization an important factor in national affairs of concern to engineers. L. W. Wallace, the executive secretary, expressed the opinion before the meeting that the future of the Federation would depend, in great measure, on the spirit and enthusiam displayed by the board at this meeting. Mr.



MORTIMER E. COOLEY
Hoover's Successor as President of F. A. E. S.

Wallace predicted that there soon will be more general recognition "that the Federation has a place and a purpose and is on its way to their realization."

The board spent more than twelve hours in its deliberations. While most of that time was taken up with matters of routine character, a number of definite accomplishments were achieved. Mortimer E. Cooley, a dean of the colleges of engineeering and architecture of the University of Michigan, was elected president of American Engineering Council to fill the vacancy created by the resignation of Herbert Hoover, made necessary by his appointment to the portfolio of commerce in the Cabinet of President Harding. It is understood that Dean Cooley has made arrangements that will enable him to give one-fourth of his time to active work for the organization.

Dean Cooley is a past president of the American Society of Mechanical Engineers and has a long record of service in education, government work and private enterprises. He was born in Canandaigua, N. Y., March 28, 1855, and was graduated from the United States Naval Academy in 1878. With his classmate, Dr. Ira N. Hollis, he was ordered to the U. S. S. "Quinnebaug," then fitting out at the Norfolk Navy Yard preparatory to a cruise in the Mediterranean. The ship sailed the following December, and Dean Cooley spent fifteen months on the "Quinnebaug" and then returned to America on the U. S. S. "Alliance."

Later he was detailed to the University of Michigan for three years under a law permitting the Secretary of the Navy to detail engineer officers as professors of "Steam Engineering and Iron Shipbuilding," and thus began his long connection with the university, which has been his life work and has covered a period of nearly forty years.

In 1902 Mr. Cooley assisted in the appraisal of the mechanical equipment of Newfoundland railways and in 1903 acted as consulting engineer in the Wisconsin railroad appraisal. In 1906 he was a member of the Traction Valuation Committee, Chicago; in 1907 appraised Michigan telephone properties; he was in charge of appraisal of hydro- and steam-electric properties and railroads for the Michigan Railroad Commission since 1910. The total value of the property with which he has been concerned in appraising is about a billion and a half dollars, of which 85 to 90 per cent has been for the public.

Since 1906 he has investigated public utilities in Minneapolis, Milwaukee, Cleveland, St. Louis, Boston, New York and several other cities. From 1907 to 1912 he acted as chairman of the Block Signal and Train Control Board, Interstate Commerce Commission. At the Chicago Exposition Mr. Cooley was a member of the Engineering Committee. At the Pan-American Exposition he was on the Committee of Awards.

Mr. Cooley has been vice-president of the American Association for the Advancement of Science (1898); director of the American Society of Civil Engineers (1913-1916); vice-president of the Society for the Promotion of Engineering Education (1908-1909); president of the Michigan Engineering Society (1903). He became a member of the American Society of Mechanical Engineers in 1884 and served as vice-president during the year 1902-1903, and in 1916-1917 as chairman of the executive committee, Detroit Section. During 1918-1919 he served as president of the society.

More attention was given the report of the special commission on employment service, of which Morris L. Cooke is chairman, than to any other single subject taken up by the board. From the discussion, a resolution was evolved that points out the pressing need for a unified employment service for engineers "national in scope, local in application and financed for adequate service." It having been found that the constituent societies are not able to provide a free service, the executive board indorsed the principle of a paid employment service, but with reduced fees for members of the organizations that support it. The chairman of the executive board is to appoint a committee of five members while each of the boards of the four founder societies is to designate one of its members so as to provide a committee of nine members on engineering employment. This joint committee is to organize the employment bureau.

The Committee on Finance was given broad powers to deal with financial arrangements with member societies. At the time the Federation was formed, the numerical strength of most engineering societies was at its peak. With the industrial depression there have been losses of members and several suggestions to relieve the situation have been offered.

The Council adopted the report of the Committee on Patents, headed by Edwin J. Prindle, of New York, urging the passage of the Lampert Bill to remedy conditions in the Patent Office, which, the committee asserted, were menacing the nation's industrial and agricultural welfare.

The executive board approved the recommendation of the committee that it indorse the classification of engineers as proposed by the Committee on Classification and Compensation of Engineering Council in its report of Dec. 15, 1919, as in the judgment of the board generally applicable to all branches of engineering.

The board announced the resignation as assistant secretary of A. C. Oliphant, who is to become associated with M. O. Leighton & Co., consulting engineers, of Washington.

The applications for membership of the Vermont Engineers Society and the Associated Engineers of Spokane were approved.

A resolution proposed by W. W. Varney, of Baltimore, provided for the publication of a journal by the Federated Societies. Most of the members of the board were not prepared to vote on such an important matter as is involved in the embarking in a pretentious publication activity. The proposed resolution was referred to the committee on printing.

Authority was given to Secretary Wallace to form administrative committees in the several states. These committees are to be the channel for the dissemination of information to engineers and are to co-operate generally when the necessity arises for assistance from some particular state or Congressional district.

The Engineering Assembly, which was being considered in connection with the annual meeting of the Council, in January, was abandoned. The feeling was that the business depression would militate against the success of a general meeting of engineers at that time.

After listening to the report of the committee on licensing, the board decided that further work must be done in perfecting the uniform licensing bill. The whole matter was recommitted.

Those in attendance were: G. S. Williams, Ann Arbor, Mich.; Lloyd B. Smith, Topeka, Kan.; Arthur M. Greene, Jr., Troy, N. Y.; William McClellan, Philadelphia, Pa.; S. H. McCrory, Washington, D. C.; H. E. Howe, Washington, D. C.; Morris L. Cooke, Philadelphia, Pa.; W. B. Powell, Buffalo, N. Y.; C. F. Scott, Yale University; W. W. Varney, Baltimore, Md.; L. P. Alford, New York City; P. N. Moore, St. Louis, Mo.; W. E. Rolfe, St. Louis, Mo.; Calvert Townley, New York City; Fred J. Miller, Stockton, N. Y.; Edwin Ludlow, New York City; Arthur S. Dwight, New York City; J. P. Channing, New York City; O. H. Koch, Dallas, Tex.; D. S. Kimball, Ithaca, N. Y.

Power Distribution in Industrial Plants

On Saturday evening, Oct. 1, at the Engineers' Club, the Philadelphia Section, Association of Iron and Steel Electrical Engineers, held its first meeting of the season, chairman George H. Schaeffer presiding. One paper, "Power Distribution in Industrial Plants," was presented by K. M. Raynor, assistant superintendent, electrical department, Lehigh Plant, Bethlehem Steel Co. The paper described the 6,600-volt power distribution system in use at the Lehigh plant. A loop system is used which ties together six substations, and the capacity of the power system connected to the distribution lines is 50,000 kva. The line consists of six or twelve conductors carried on steel towers. The cables are grouped in pairs to form split conductors, each three pairs constituting a three-phase circuit. In passing through the substations, the conductors are grouped to form a single three-wire circuit and pass through an oil switch to the busbars from which local distribution is made. From the busbar the main distribution circuit goes through another oil switch, after which the circuit is again divided to form a split-conductor system. Current transformers are connected into each of the incoming and outgoing lines of the split-conductor system and these transformers grouped and connected to relays in such a way that when the system is in a state of unbalance equivalent to 50 per cent of normal rated load, the oil switches at each end of the section in trouble will be tripped. The current transformers are connected in to operate the relays similarly to the differential relay systems of protection used on large alternators. Mr. Raynor pointed out that there are two important factors involved in power transmission; namely, continuity of service and the cost of delivering the power. Of the two it was felt that continuity of service is the most important. The system described has been in operation two years and has successfully taken care of all troubles with one exception. In this case the relays were adjusted to trip out on 100 per cent unbalance. Since that time the relays have been adjusted for 50 per cent unbalance, and no further trouble has been experienced.

In discussing the paper, Harold Goodwin called attention to the great work that had been done in developing relays to a point where they are almost superhuman in what they will do. The cost of the best relay protection for the system is only a very small fraction of one per cent of the total cost of the system. The cost of the relays compaired with the protection they give is practically negligible.

R. B. Gerhardt compared the radial system of distribution with the loop system and pointed out that large bulks of power cannot be taken care of as efficiently and with the same degree of reliability by a radial system as with the loop system. However, each problem has to be worked out on its own merits. The speaker called attention to one large overhead radial system of distribution that gave so much trouble that it was put underground. A preference was expressed for the watt-meter-type relay over the bellows type. With the radial system of distribution the control of the whole system can be concentrated at one locality which is not possible with the loop system. To make sure that sufficient capacity was connected to a loop system to take care of the load it was necessary to communicate with the power house before starting up any large equipment.

There are two types of loop systems of distribution; namely, the split-conductor system and the simple loop protected with inverse-time overload and reverse-power relays. With the simple-loop system on account of the time setting of the relays and the time required for the oil switches to open, the number of substations that can be located on the system is limited to about five or six. With the split-conductor system having balanced-relay protection, there is no limit to the number of substations that may be put on the system. In discussing these limitations, it was pointed out that relays could be adjusted to trip on 0.1-sec. settings, but the oil switch required from 0.3 sec. to 1 sec. to open. One of the most serious objections raised against the balanced-relay system of protection was that it did not afford any protection in case of trouble on the substation busbars. It was recommended that the busbar installation be made so good that the possibility of trouble developing would be very remote.

Water-Power Applications

The most important applications for licenses and preliminary permits received by the Federal Power Commission during September are as follows:

Frank C. Dougherty, Palace Hotel, San Francisco; preliminary permit; four power projects on Crater, Long and Tease Lakes and at Sweetheart Falls,near Port Snettishham, Alaska; pulp and paper manufacture; installed capacity, 80,000 h.p.; power capacity, 66,000 h.p.; conflicts with the application of the Speel River Company.

W. H. Samson, Corning, Cal.; preliminary permit; power project, Stuarts Fork of Trinity River; public utility; power capacity, 15,000 h.p.; installed capacity, 25,000 h.p.

Southern Sierras Power Co., First National Bank Bldg., San Francisco; preliminary permit; power project; Bear Creek and Santa Ana River, Riverside County, Cal.; public utility; power capacity, 5,000 h.p.; installed capacity, 25,000 h.p.; all in conflict with the applications of J. G. Van Zandt.

Lars Jorgensen, Chronicle Bldg., San Francisco; preliminary permit; three major and three minor projects on the Middle Fork of Feather River in Plumas, Sierra and Butte Counties, Cal.; the project contemplates the creation of six large reservoirs, storing a total of 372,000 acre-feet, the construction of several diversion dams, several miles of conduits and tunnels and six power houses; public utility; power capacity, 200,000 h.p.; installed capacity, 350,000 h.p.; in partial conflict with the application of the Richpoint Mining Co., the Great Western Power Co. and with the application of R. T. Harding.

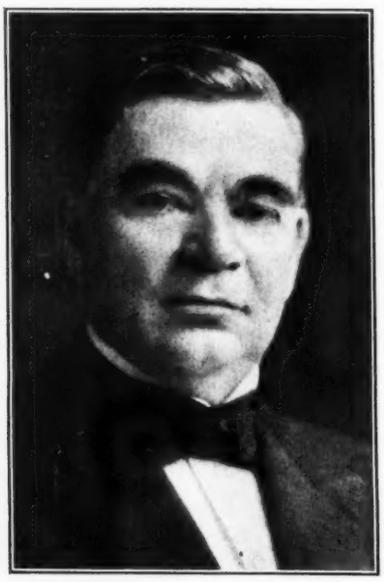
Northern States Power Co., 208 South LaSalle St., Chicago; preliminary permit; six projects on the Mississippi and the St. Croix Rivers in Burnett and Polk Counties, Wis., and in Pine and Chicago Counties, Minn.; public utility; power capacity, 30,000 h.p.; installed capacity, 60,000 h.p.; in direct conflict with applications of J. D. Markham and of the St. Cloud Electric Power Company.

R. T. Harding, 105 Montgomery St., San Francisco; preliminary permit; power project, Bucks and Grizzly Creeks, Plumas County, Cal.; mining and manufacturing; power capacity, 7,900 h.p.; installed capacity, 15,800 h.p.; in conflict with applications of Lars Jorgensen and of the Great Western Power Company.

Rio Grande Light, Heat and Power Co., Albuquerque, N. M.; license; power project in Rock Canyon, Sandoval and Santa Fe Counties, N. M.; public utility; power capacity, 2,750 h.p.; installed capacity, 25,000 h.p.

Charles H. Garlick Dead

Word has recently been received of the death of Charles H. Garlick, past president of the National Association of Stationary Engineers, and for some years state boiler inspector for Allegheny County, Pa. Mr. Garlick died at his home in Bellevue, Pa., where he was well known in business and fraternal circles, having been especially active in the affairs of the Masonic and Maccabee orders. He was also a member of the Ohio Society of Mechanical and Electrical Engineers and the Engineers' Society of Western Pennsylvania, was head of the Universal Council of Craftsmen, an engineering association, and had served as president of the National Association of Stationary Engineers. He did considerable writing for engineering journals, and some readers will recall him as an occasional contributor to *Power*. He also lectured on boilers and combustion, upon which subjects he was considered an authority by those who knew him.



CHARLES H. GARLICK

Mr. Garlick was born March 31, 1859, in Mantua, Ohio, and at the age of six years moved with his parents to Tarentum, where he lived for a number of years. He served as efficiency expert for a period of over 17 years with the Atlantic Refining Co., and in February, 1912, he was appointed the successor of J. J. Kelly, also of Bellevue, as state boiler inspector for Allegheny Co., a position reputed to be worth about $12,000 a year. He held this position until the latter part of 1920, when he relinquished it to A. J. Bell, his assistant, who had been connected with the office for over twenty years.

Work on Big Creek No. 3, the fourth plant in the Southern California Edison Co.'s Big Creek Development, is soon to be started. The maximum static head will be 825 ft. and the ultimate capacity 25,000 kw., in six units. It is planned to have the first unit in operation in the Spring of 1923. The transmission voltage will be 220,000.

New England States N. A. S. E. Has Employment Bureau

An employment bureau, which was sanctioned at the last convention of the New England States Association of the National Association of Stationary Engineers, has recently been organized, and the committee that has been formed to handle the work has issued a request that anyone having a vacancy, or knowing of one, for an engineer or fireman let them know of the fact.

The committee aims to extend its activities and to be able to furnish reliable engineers and firemen anywhere in New England. The names and addresses of the committee members are given herewith, so that anyone having a vacancy or wishing to find one may get in touch with the nearest member: Lincoln A. Couch (chairman), 100 Pearl St., Boston, Mass.; Ernest Mutch, 419 Boylston St., Boston, Mass.; George W. Knowlton, 60 Pearl St., Boston, Mass.; Thomas A. Ray, 48 Pearson Ave., Somerville, Mass.; John H. Mullen, 20 Willow Ave., West Somerville, Mass.; Dudley G. Kimball (pro tem), 62 Clifton St., Boston 25, Mass.

New Sales Tax Proposed

Senator Smoot, a member of the Senate Finance Committee who is dissatisfied with the committee's revised tax bill, has submitted amendments in the nature of substitutes, including a 3 per cent sales tax which would apply to the coal industry. The tax would be upon every commodity manufactured or produced when sold, leased or licensed for consumption or use without further process of manufacture. The tax will be equivalent to 3 per cent of the price for which the commodity is sold, leased or licensed, and will be paid by the manufacturer or producer.

In a statement explaining the tax, the Senator says that as it is imposed only when articles are "for consumption or use without further process of manufacture," that the tax will not be cumulative, to meet objections advanced against his original sales tax announced last spring. "For example, coal sold for consumption in a boiler will be taxable, but coal sold for the manufacture of coke will not, the coke bearing a tax when sold," explained the Senator. The tax is to be paid monthly, beginning January next, but an exemption on sales up to $6,000 a year is allowed. Computations were made in co-operation with the Census Bureau based on 1919 business, including the estimated production of coal.

New England to Have Power Show

In conjunction with the International Textile Exposition a "Power Show" will be held from Oct. 31 to Nov. 5 in Boston. The combining of the two events under one roof and at the same time is expected to prove advantageous both to the textile men and the engineers and to add considerably to the interest of the affair, especially as the various kinds of textile machinery will be shown in full operation. The exhibit hall secured is in the Mechanics' Building, in the Back Bay district of Boston.

The New England States Association of the National Association of Stationary Engineers will have a booth on the lower floor in charge of a committee headed by the New England president, Dudley G. Kimball, whose address is 62 Clifton St., Boston 25. *Power* will have a booth and the usual representation. Major James W. H. Myrick, 53 Devonshire St., Boston, is treasurer of the New England Association of Commercial Engineers, and has charge of arrangements for the exhibits.

The American Society of Safety Engineers has been designated as sponsor for a Safety Code for Compressed Air Machinery by the American Engineering Standards Committee. The code will include rules for the construction and use of compressors, tanks, pipe lines, and the utilization apparatus where compressed air is the active agent. In accordance with the usual procedure the code will be formulated by a sectional committee composed of representatives designated by the various bodies interested.

New Publications

MECHANISM. By Robert McArdle Keown, Engineer, Industrial Commission of Wisconsin, formerly Associate Professor of Machine Design, University of Wisconsin. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Second edition, 1921. Cloth 5¾ x 9 in.; 168 pages; 172 illustrations. Price $2.25 postpaid.

This new edition covers substantially the same ground as the first edition, but the number of problems has been doubled and most of the illustrations have been enlarged for the sake of clearness. This book was prepared primarily as a text for use in engineering courses, and particularly for a half-year's work consisting of one lecture, one recitation and four hours of drafting work per week. The large number of problems supplied, most of which are to be worked out on the drafting board, render the book especially available for home use as well as for instruction in technical schools. The main subjects covered are as follows: Motions and velocities, instantaneous centers, kinematic chains, solution of relative linear velocities by centro method, velocity diagrams, parallel and straight-line-motion mechanisms, cams, gearing, bevel gears, worm and wormwheel, gear trains, belting and intermittent motions. Particular attention is given to cams, as they form a part of the subject in which the student needs considerable practice in order to work out original plans, and practically all cam problems are original.

Personals

Major Fritz Lindh has left the Graton & Knight Manufacturing Co. to join the sales organization of the Chicago Belting Co. Major Lindh is a graduate of West Point and has served in the army for about six years, having charge of the government tests of materials at Sandy Hook during the war. He is to have charge of the Pittsburgh factory branch of the company.

The College of Engineering of the University of Illinois, Urbana, Ill., has announced a number of new appointments to its teaching staff, some of which should be of interest to *Power's* readers. In the Department of Electrical Engineering, Cornelius S. Bullions has been appointed instructor, after about four years in the testing and turbine-construction department of the G. E. company; Charles Alva Keener, selected as an instructor, secured his degree in electrical engineering from the Massachustts Institute of Technology in 1920 and attended the test courses of the G. E. company and the Westinghouse company; Trice Morton Bell, assistant instructor, has been with the G. E. company for two years, having been in the testing and designing departments; Edward Everett Perkins, appointed assistant instructor, has had experience in a number of companies since his graduation in 1917, among them being the Westinghouse company, the Carroll Electric Co. and the Terry & Tench Co. A new assistant professor of mechanical engineering is William H. Severns, who is the author of a book on "Strength of Materials," has had considerable teaching experience and was employed by the New Jersey Zinc Co. in the investigation of a new design of Stirling waste-heat boiler. Frank C. Linn, who has been recently in the testing and turbine-engineering department of the G. E. company, is a new assistant instructor in mechanical engineering.

Society Affairs

Bridgeport Branch, A. S. M. E., will meet October 20 at the Stratfield Hotel to hear an address on "The Relation of Engineering and Management," by Walter Rautenstrauch.

Metropolitan Section, A. S. M. E., is to hold a joint meeting with the A. I. E. E. A. S. C. E. and A. I. M. M. E. in the Engineering Society Building, New York City, October 19. The subject discussed will be "Engineering Financing."

Business Items

The Pittman-Smith Engineering Co. has been organized by E. W. Pittman and H. P. Smith, formerly general manager and chief engineer, respectively, in the engineering works department of the Dravo Contracting Co. The new firm will handle the designing of power plants, machinery layouts and all types of industrial buildings.

Trade Catalogs

The Power Specialty Co., 111 Broadway, New York City, has published an unusually interesting 30-page bulletin describing the Foster Superheater. The arguments in favor of the use of superheating are given and there is a number of good installation photographs and diagrams showing the method of application of the Foster Superheater to various types of boilers.

The Hadfield-Penfield Steel Co. has published two catalogs on its horizontal and vertical two-stroke-cycle Diesel engines, which are built with a crosshead that serves also as a pumping piston for furnishing scavenging air. The horizontal engine is built in three sizes of cylinders and of 50, 150 and 200 b. hp., while the vertical engine is built in two cylinder sizes, 50 and 125 b. hp. per cylinder, in from two- to six-cylinder units.

The Hardinge Co., 120 Broadway, New York City, is distributing a new 16-page catalog entitled "Pulverized Fuel." The company has for some time been making pulverizing mills, and has recently developed a product for use with coal. The booklet takes up the general subject of burning powdered fuel, and describes the principles and method of application of the Hardinge Pulverizing System. The three principal advantages of powdered coal are given as: Increased efficiency of combustion, utilization of low-grade fuel and flexibility of operation.

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	Sept. 27, 1921	Oct. 4, 1921
Pool 1,	New York	$3.25	$3.00@3.50
Pocahontas,	Columbus	2.65	2.65@2.90
Clearfield,	Boston	1.90	1.70@2.15
Somerset,	Boston	1.75	1.50@2.10
Pittsburgh,	Pittsburgh	2.20	2.20@2.25
Kanawha,	Columbus	2.00	1.90@2.15
Hocking,	Columbus	2.15	1.90@2.10
Pittsburgh No. 8	Cleveland	2.10	2.00@2.15
Franklin, Ill.,	Chicago	2.95	2.00@3.50
Central, Ill,	Chicago	2.40	1.75@2.75
Ind. 4th Vein,	Chicago	2.40	2.30@2.75
Standard,	St. Louis	1.95	1.65@2.00
West Ky.,	Louisville	2.25	2.00@2.50
Big Seam,	Birmingham	2.15	2.00@2.30
S. E. Ky.,	Louisville	2.20	2.00@2.15

New York—On Oct. 5, Port Arthur light oil, 22@25 deg. Baumé, 4c. per gal. 30@35 deg., 5c. per gal. f.o.b. Bayonne, N. J.

Chicago—Sept. 10, for 24@28 deg. Baumé, 40@45c. per bbl.; 32@36 deg. 1¼@1½c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—On Sept. 10, f.o.b. refinery; Pennsylvania, 36@40 deg., 3¼ to 4c.; Oklahoma, 24@30 deg., 50@55c. per bbl.; gas oil, 32@34 deg., 1¼c. per gal., 36@38 deg., 1¼c. 38@40 deg., 1¾c.

St. Louis—Oct. 1, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 45c. per bbl.; 26@28c. deg., 55c.; 28@30 deg., 60c.; 32@34 deg. 1¼c. per gal.

Philadelphia—On Oct. 4, 26@28 deg. Baumé, Oklahoma, 50c. per bbl.; 30@34 deg., Oklahoma (group 3) 75c. per bbl.; 16@20 deg. Seaboard, 3c. per gal.

Cincinnati—Sept. 26, for 38 deg. Baumé, 4½c.; Diesel, 28@39 deg., 3¾c. per gal.

Cleveland—Sept. 26, for 22@28 deg. Baumé, 5.848c. per gal.

New Construction

PROPOSED WORK

R. I., Pawtucket—The city Bd. Educ. plans to build a 3 story school including a manual training and industrial arts school on Fountain St. About $1,200,000. Architect not selected.

Conn., New Haven—Yale University, J. R. Angell, Pres., plans to build a library on the campus. About $2,000,000. Architect not announced.

Conn., New Haven—Yale University, J. R. Angell, Pres., is having plans prepared for a 2 story museum on the campus. About $750,000. Gay & Klauder, 925 Chestnut St., Phila., Pa., Archts.

D. C., Washington—A. L. Flint, Gen. Purchasing Officer, of the Panama Canal, will receive bids until Oct. 18 for furnishing 4 cycle, 4 cylinder, 17 to 25 hp. gasoline Engine, complete with equipment.

N. Y., Brooklyn—The Bikur Cholin Hospital, Lafayette and Summer Aves., plans to build a 4 story hospital at 810 Bushwick Ave. About $1,000,000.

N. Y., Brooklyn—The White Metal Rolling & Stamping Corp., 314 Calyer St., is in the market for a 35 to 50 hp. slip ring, A.C. motor, 650 to 900 R.P.M., 2 phase.

N. Y., New York—The American Nut & Seed Oil Corp., 562 East 76th St., is in the market for a 5 hp. motor and three 15 hp. motors.

N. Y., New York—Libbins Baths Inc., 299 Bway., will soon receive bids for a 6 story turkish bath and store building on Chrystie St. and Schiff Pkway. About $1,000,000. B. H. and C. R. Whinston, 2 Columbus Circle. Archts and Engrs.

N. Y., New York—M. A. and W. A. Touhy, 15 Broad St. are in the market for one 3,000 gal. per min. steam pump with suction lift of 12 ft. and one 2,500 gal. per min. steam pump with 10 ft. suction lift.

Pa., Oakmont—The Suburban Water Co. is having plans prepared for additions to pumping station. About $80,000. J. N. Chester, Union Bank Bldg., Pittsburgh, Engr.

D. C., Washington—P. M. Julian, Commercial Natl. Bank Bldg., Archt., is preparing plans for an apartment. About $600,000. Owner's name withheld.

W. Va., Wheeling—The Tri-State Hotel Co. plans to build a 19 story hotel. About $600,000. Architect not selected.

N. C., Cape Hatteras—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to build a radio station here. Spec. 4522.

N. C., Charlotte—The city plans improvements to waterworks including new pumping station. About $300,000. W. E. Vest, 806 West Trade St., Engr.

N. C., Charlotte—J. H. Little, 13 North Poplar St., and others plan to build an 8 story office building. About $250,000. Architect not selected.

N. C., Goldsboro—The State Hospital for Insane is having plans prepared for constructing and equipping a power house. About $100,000. H. A. Underwood, 227 Forest St., Raleigh, Engr.

N. C., High Point—The Commercial Natl. Bank, J. E. Cox, Pres., is having plans prepared for a 10 story bank on Main St. About $500,000. C. C. Hartman, Greensboro, Archt.

N. C., Lenoir—The Caldwell Power Co. is having surveys made for a hydro-electric development on Wilsons Creek to develop not less than 3,000 hp. About $50,000. Tucker & Laxton, Realty Bldg., Charlotte, Engrs.

Fla., Valparaiso—A. P. Kastler, City Clk., will receive bids until Oct. 18 for one internal combustion motor, belt connected to centrifugal or rotary, pump, 150 to 200 G.P.M., one 30,000 gal. tank on 100 ft. tower, watermains, etc.

La., Alexandria—Treasury Dept., J. A. Wetmore, Supervising Archt., Washington, D. C., will receive bids until Oct. 19 for an ice making refrigerating plant in the United State Public Health Service Hospital here.

O., Lorain—The Bd. Educ., E. Bruell, Clk., will receive bids until Oct. 20 for a 2 story high school including a steam heating system on East 20th and Oakdale Sts. About $250,000. F. C. Warner, Hippodrome Annex Bldg., Cleveland, Archt.

O., Lorain—The Bd. Educ., E. Bruell, Clk., will receive bids until Oct. 20 for a 2 story high school including a steam heating system on East 31st St. and Seneca Ave. About $250,000. F. C. Warner, 767 Hippodrome Annex Bldg., Cleveland, Archt.

O., Painesville—The Bd. Educ., C. J. Wadsworth, Pres., is having plans prepared for a 2 story high school, including a steam heating system. About $350,000. F. L. Packard, New Hayden Bldg., Columbus, Archt.

O., Painesville—The city received bids for a 1 story, 40 x 80 ft. power plant from F. W. Mark Constr. Co., Leader-News Bldg., Cleveland, $20,965; Complete Constr. Co., 3129 Scranton Rd., Cleveland, $21,221.

O., Toledo—The Bd. Educ. c/o Bd. Educ. Administration Bldg. will receive bids until Oct. 19 for a 3 story, 251 x 344 ft. school including a steam heating system. Cost over $1,000,000. E. M. Gee, Engr.

Mich., Detroit — The Harper Hospital, John R. St. and Martin Pl., c/o A. Kahn, Archt., 1000 Marquette Bldg., is in the market for belt conveyors for coal, ash hopper and conveyors stokers, pumps & 3 boilers. The contract for the construction of a 1 story, 84 x 106 ft. power house, was awarded to E. Winters, 725 Detroit Savings Bk. Bldg.

Ill., Herrin—Dr. C. Baker plans to build a 4 story hospital, including a steam heating system. About $300,000. Architect not selected.

Ill., Sterling — B. Wilson, representing stock company, 327 La Salle St., Chicago, plans to build an 8 story hotel, including a steam heating system. About $500,000. Architect not selected.

Ill., Waukegan—The city, c/o M. J. Douthit, Engr., is having plans prepared for a filtration plant and pumping station. About $600,000.

Wis., Beaver Dam—The Bd. Educ., c/o A. W. Lueck, Chn., plans to build a 4 story, 160 x 210 ft. high school including a steam heating system on Main St. About $300,000. Architect not selected.

Wis., Green Bay—The Bd. Educ., A. W. Burton, Secy., plans to build a 4 story, 150 x 200 ft. vocational school. Cost between $250,000 and $300,000. Architect not selected.

Wis., Hartford—Portz Malt & Grain Co. is having plans prepared for a 50 x 90 ft. power plant including tube boilers, overhead ash handling devices, etc. About $100,000. J. Thorn, Hartford, Engr.

Wis., Jones Island—(Milwaukee P. O.)—The City Sewerage Comn. Milwaukee, will receive bids until Oct. 14 for a foundation for a 68 x 166 ft. boiler house.

Wis., Madison—W. R. McNeil, c/o Capitol Hotel, 206 King St., is having plans prepared for a 6 story hotel on Lake Mendota. About $750,000, W. W. Ahlschlager, 65 East Huron St., Chicago, Ill., Archt.

Wis., Milwaukee — The Comr. of Pub. Wks., will receive bids until Oct. 24, for one 25 and two 22 million gal. vertical triplex expansion crank and flywheel pumping engines with auxiliaries, etc., for Riverside Pumping Station. G. Staal, City Hall, Engr.

Wis., Nelsonville—H. J. Kankrud is having plans prepared for a 2 story, 48 x 130 ft. saw mill including a steam power plant and boiler room. About $55,000. Private plans.

Wis., Wausau—D. L. Plumer Hospital will soon receive bids for a 4 story hospital. About $300,000. Berlin, Swern & Randall, 19 South La Salle St., Chicago, Ill., Archts.

Ia., Dubuque—The city, c/o J. Stuber, Clk., is having plans prepared for a pumping station and new mains. About $35,000. D. H. Maury, 33 West Jackson Blvd., Chicago, Ill., Engr.

Ia., Oskaloosa—The city, c/o T. H. Carlin, Clk., plans to build a hydro-electric plant on the Des Moines River including a dam to furnish 4,000 hp.

Minn., Forest Lake—The Village, T. D. Arends, Recorder, will receive bids until Oct. 14 for a 27 ft. well and a pump house, one triplex and one centrifugal pump with motors, piping, switchboard, etc. About $15,000. Druar & Milinowski, 504 Globe Bldg., St. Paul, Engrs.

Kan., Coffeyville—F. R. Lawson, Nowata, Okla., is having plans prepared for a 2 story ice plant. About $100,000. Architect not announced.

Kan., Lawrence — The University of Kansas, J. A. Kimball, Bus. Mgr., Topeka, will receive bids until Oct. 14 for a 2 story, 53 x 110 ft. addition to electric laboratory. About $40,000. R. L. Gambell, 1415 Fillmore St., Archt.

Kan., McCracken—The city, c/o L. L. Ryan, City Mgr., voted bond issue of $55,000. for a 50 x 55 ft. addition to power plant including the installation of 2-75 kva. generators with exciter and 5 panel switchboard. Ruckel Eng. Co., Hutchinson, Engrs.

Kan., Winfield—The Chamber of Commerce, representing a stock company, plans to build a 3 story hospital including a steam heating system. About $250,000 Architect not selected.

S. D., Sioux Falls—The Bd. Educ., B. S. Van Slyke, Clk., will receive bids until Oct. 14 for a 2 story, 78 x 178 ft. addition to high school including a steam heating system. About $300,000. Perkins & McWayne, 322 Paulton Blk., Archts.

Mo., Kansas City—The Kansas City Stock Yards, c/o W. H. Weeks, Live Stock Exchange, is having plans prepared for a 2 story, 300 x 870 ft. exposition building including a steam heating system on 23rd and Trafficway Sts. About $400,000. Architect not announced. Owner builds by day labor.

Mo., Liberty—The city, c/o E. B. Black, Clk., is having plans prepared for a 235,000 gal. capacity steel stand pipe water softening plant; two-500,000 gal. capacity electric driven low service pumps and two-500,000 gal. capacity electric driven high service pumps. About $60,000. W. E. Barnes, Liberty, Engr.

Mo., St. Louis—Grand & Washington Real Estate Co., c/o J. C. Campbell, 107 North 7th St., plans to build a 5 story store and office building, including a steam heating system, on Grand and Washington Sts. About $270,000. Architect not selected.

Col., Denver—The County Club Apartment Co., 535 17th St., is having plans prepared for a 6 story apartment. About $1,400,000. H. W. J. Edbrook, Tabor Opera House Bldg., Archt.

Col., Denver—The General Iron Wks., Co., 720 California St., recently incorporated, plans to build an iron foundry on 33rd and Blake Sts. About $500,000. J. R. Henderson, 1720 California St., Engr.

Col., Denver—The Super-Service Motor Assn., Colorado Bldg., plans to build a 3 story, 125 x 250 ft. co-operative motor repair plant on Speer Blvd., Bannock and West 7th Aves. About $300,000. H. W. J. Edbrooke, Tabor Opera House Bldg., Archt.

Utah, Salt Lake City—The B. P. O. E., Lodge No. 85, will soon receive bids for a 5 story, 83 x 147 ft. club house on East South Temple St. About $300,000. Scott & Welch, Dooly Bldg., Archts.

Wash., Seattle—(Change of date) The Bd., Pub. Wks., will receive bids until Oct. 14 for a tunnel for the Gorge Creek plant of the Skagit River power development. About $2,000,000. Noted Sept. 20.

Cal., Los Angeles—The County Bd. of Supervisors, Hall of Records will receive bids until Oct. 17 for furnishing and installing engine generator set in power house at the County Hospital. About $15,000.

Cal., Los Angeles—The County Bd. of Supervisors will receive bids until Oct. 17 for a 3 story, 156 x 158 ft. hospital including a steam heating system & refrigeration plant. About $300,000 W. Davidson, Mechanical Dept. Hall of Records, Archt. and Engr.

Cal., Santa Maria—The Bd. Educ. will soon receive bids for a 1 and 2 story, 250 x 300 ft. high school including a steam heating system. About $400,000. Allison & Allison, Hibernian Bldg., Los Angeles, Archts.

Ont., Centralia—The Council, c/o T. Willis is having surveys made for a complete new plant for lighting and power distribution. About $25,000. J. N. Wilson, 190 University Ave., Engr.

Ont., Grand Bend—The council, c/o J. Ross, is having surveys made for a hydro-electric lighting and power distribution system. About $25,000. H. W. Doerr, Exeter, Engr.

Ont., Wilkesport—The Township Council, R. Selman, is having surveys made for an electric light and power distribution system including a power house on the Snye River. About $45,000. A. Lawler, 190 University Ave., Toronto, Engr.

CONTRACTS AWARDED

Mass., Ware — Ware Woolen Co. has awarded the contract for a boiler house to H. P. Cummings Constr. Co.

N. Y., Brooklyn—The Milboro Building Corp., 1466 49th St., Brooklyn, will build a 4 story apartment on Regent Place and East 21st St. About $250,000. Seelig & Finkelstein, 44 Court St., Engrs. Owner will build by day labor.

N. Y., New York—The Bd. Educ., 500 Park Ave., has awarded the contract for a 5 story school on Amsterdam Ave., between 188 and 189th Sts. to E. Diebitch, 383 Madison Ave., $587,000. Noted April 26.

N. Y., New York—The Estate of L. S. Bryce, c/o F. F. French, Archt., Madison Ave. at 41st St., will build a 14 story apartment on 5th Ave. and 95th St. About $500,000. Contract has been awarded to architect.

N. Y., New York—J. Paterno, 719 West 115th St., will build a 6 story apartment on East 163rd St. About $325,000. Owner will build by day labor.

N. J., Rutherford—The Bd. Educ., has awarded the contract for a 2 story high school to T. T. Hearter, West New York, N. J. About $325,000. Noted Sept. 20.

Pa., Phillipsburg—The S. & S. Shirt Co., Phillipsburg, had awarded the contract for a 3 story, 60 x 150 ft. factory to the Turner Constr. Co., 1713 Sansom St., Philadelphia. About $150,000.

O., Cleveland—The Bd. Educ., F. Hogen, Dir., East 6th St. and Rockwell Ave., has awarded the contract for a 3 story school on Sunbeam St. to C. C. Kinne Co., Bangor Bldg., $353.700.

O., Cleveland—The City Ice & Fuel Co. has awarded the contract for a 1 story, 52 x 75 ft. ice plant on Addison Rd. to Younger & Farmer Co., 1670 Crawford Rd. About $100,000.

O., Cleveland—The Cleveland Elec. Illuminating Co., 75 Public Sq., has awarded the contract for a 2 story, 26 x 55 ft. addition to electric sub-station on East 17th St. to Hunkin-Conkey Constr. Co., Century Bldg. About $50,000. Noted Sept. 27.

O., Toledo—The Board Educ. has awarded the contract for a 2 story, 100 x 200 ft. school on East Bway. to A. Bentley Sons Co., 201-31 Belmont Ave., $389,890. Steam heating system will be installed.

Ill., Moline—F. L. Cornwall, La Salle Bldg., St. Louis, Mo., will build a 15 story, 68 x 150 ft. hotel. About $900,000. A. D. Gates, Supt. of Constr. Noted Sept. 20.

Wis., Milwaukee—The Holeproof Hosiery Co., 41 Fourth St., had awarded the contract for a 3 story, 58 x 150 ft. factory on 30th St. to W. W. Oeflein, 86 Michigan St. About $100,000. Motors will be installed.

Mo., St. Louis—The Missouri Pacific Ry., California and Eads Sts., has awarded the contract for a 7 story, 121 x 182 ft. hospital on Grand and Shaw Sts. to J. Stewart & Co., Boatmens Bk. About $500,000. Noted July 19.

Tex., Beaumont—San Jacintor Life Insurance Co. has awarded the contract for a 12 story, 60 x 115 ft. office building to J. Stewart, 214 1st West Bank Bldg. About $600,000.

Cal., Long Beach—Findley Constr. Co. and Associates, East Ocean Blvd. and 2nd Pl., will build a 7 story, 50 x 172 ft. apartment including laundry & refrigerating plant on East Ocean Blvd. About $275,000. J. H. Roberts, 213 Marine Bk. Bldg., Archt.

Cal., Los Angeles—Swift & Co., 922 East 1st St., have awarded the contract for a packing plant to R. E. Milsap, Marsh-Strong Bldg. Refrigeration system, coolers and smoke house machinery will be installed. $52,000. Noted Aug. 30.

Que., Montreal—The Westmont Industrial Corp., 21 Stanton St., has awarded the contract for a 6 story, 73 x 93 ft. apartment on Sherbrooke and Rosemount Sts. to J. Shearer & Sons, Shearer St. About $250,000.

Ont., Windsor—The Essex Provision Co., Ltd., 1120 McDougall St., has awarded the contract for a 4 story, 280 x 300 ft. packing and cold storage plant to P. H. Secord & Sons, 133 Nelson St. Steam heating system will be installed. About $500,000. Noted Aug. 16.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

Fire	50-Ft. Lengths
Underwriters' 2½-in.	56c. per ft.
Common, 2½-in.	50–5%

Air		
	First Grade	Second Grade
¾-in. per ft.	$0.38	$0.22½

Steam—Discounts from List

First grade....40–10% Second grade...50–5% Third grade....50–10–5%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition..... 60–5% Best grade..... 50–10%

LEATHER BELTING—Present discounts from list in fair quantities (½ doz rolls):

Light Grade	Medium Grade	Heavy Grade
50–5%	45%	40%

RAWHIDE LACING { For cut, best grade, 50–10%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 39c. Semi-tanned: cut, 50%; sides, 43c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$1.00
Asbestos for high-pressure steam	2.00
Duck and rubber for piston packing	1.00
Flax, regular	1.20
Flax, waterproofed	1.70
Compressed asbestos sheet	1.00
Wire insertion asbestos sheet	1.50
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.25
Asbestos wick, ½- and 1-lb. balls	.75

PIPE AND BOILER COVERING—Below are part of standard lists, with discounts.

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure 33⅓% off

For low-pressure heating and return lines { 4-ply 50% off; 3 ply 52% off; 2-ply 54% off

PORTLAND CEMENT—New York, $2.50 without bags, in cargo lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $2.88 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York Current	Cleveland	Chicago
White	7.50@10.00	12.00	12.00
Colored mixed	5.50@ 9.00	9.00	10.00

WIPING CLOTHS—Jobbers' price per 1,000 is as follows:

	13½ x 13½	13½ x 20½
Cleveland	$55.00	$65.00
Chicago	55.00	65.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.76	$0.88	$0.87

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	12.25	13.75	15.50	17.00	12.25	15.50
25- and 50-lb. keg	12.50	14.00	15.75	17.25	12.50	15.75
12½-lb. keg	12.75	14.25	16.00	17.50	12.75	16.00
1-lb. cans	15.25	16.75	18.50	20.00	15.25	18.50
5-lb. cans	17.25	18.75	20.50	22.00	17.25	20.50

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ¾ and smaller	50–10%	60–10–10%	60–10%
Tinned	50–10%	60–10–10%	45%

Structural rivets, ⅞, ¾, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.

New York.....$4.40 Chicago.....$3.68 Pittsburgh.....$2.65

Boiler rivets, same sizes:

New York.....$4.50 Chicago.....$3.78 Pittsburgh.....$2.75

REFRACTORIES—Prices in carlots:

Chrome brick, eastern shipping points	net ton	$55.00
Chrome cement, 40@45% Cr_2O_3	net ton	25.00
Chrome cement, 40@45% Cr_2O_3 in sacks	net ton	28.00
Clay brick, 1st quality, fire clay, 9-in. shapes, Pennsylvania, Ohio and Kentucky	per 1,000	28.00
Clay brick, 2nd quality, fire clay, 9-in. shapes Pennsylvania, Ohio and Kentucky	per 1,000	25.00
Magnesite brick: 9-in. straight	net ton	65.00
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50
Magnesite brick: Soaps and splits	net ton	91.00
Silica brick: Chicago district	per 1,000	38.80
Silica brick: Birmingham, Ala.	per 1,000	37.00
Silica brick: Mt. Union, Pa.	per 1,000	33.00
Magnesite cement: Eastern shipping point, in bags	net ton	.....
Magnesite cement: Eastern shipping point, in bags	net ton	.....

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
Best grade	70.00	37.50	32.00
Commercial	30.00	13.50	8.00

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting or screw stock, per 100 lb. base	$4.03	$4.00	$3.50
Flats, square and hexagons, per 100 lb. base	4.53	4.50	4.00

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list

	Current
Copper ferrules	75%
Boiler flanges	55%
Boiler stay bolts	60%
Boiler patch bolts	Net list
Boiler fitting-up bolts	50%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the Pittsburgh basing card of Sept 16, 1921:

BUTT WELD

Inches	Steel Black	Galv.	Inches	Iron Black	Galv.
1 to 3	68½	56	¼ to 1½	39½	24½

LAP WELD

2	61½	49	2	34½	20½
2½ to 6	65½	53	2½ to 4	37½	24½
7 to 8	62½	49	4½ to 6	37½	24½
9 and 12	61½	48	7 to 12	35½	22½

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	66½	55	1 to 1½	39½	25½
2 to 3	67½	56			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	59½	48	2	35½	22½
2½ to 4	63½	52	2½ to 4	38½	26½
4½ to 6	62½	51	4½ to 6	37½	25½
7 to 8	58½	45	7 to 8	30½	18½
9 to 12	52½	39	9 to 12	25½	13½

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$0.22
1¼	.....	.....	.21
1½	.....	.....	.19
1¾	$0.2332	$0.2855	.24
2	.1848	.22	.20
2¼	.2112	.2514	.22
2½	.2220	.2955	.26
2¾	.2516	3349	.30
3	.2812	.3743	.33
3¼	.3330	.4320	.32
3½	.3264	.4608	.34
4	.4148	.5856	.43

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1¼ in. to 2 in. diameter, 5c. per cut. 2¼ in. diameter, 7c. per cut
2½ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3½ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$ 43.00(net)	$138.00	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

Less than coil lots	25%	15%
Coils to 1,000 ft.	35%	30%
1,000 ft. and over	45%	35%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever-Ready:

	Each, Net
Less than 12	$0.40
12 to 50	.34
50 to 125 (bbl.)	.30½
125 (bbl.) or over	.29

CONDUIT, Price per 1,000 ft.; ELBOWS AND COUPLINGS, Per 100 pieces, f. o. b. New York, with 10-day discount of 5 per cent.

Size, In.	Conduit Black 2,500 to 5,000 Lbs.	Conduit Galvanized 2,500 to 5,000 Lbs.	Elbows Black 2,500 to 5,000 Lbs.	Elbows Galvanized 2,500 to 5,000 Lbs.	Couplings Black 2,500 to 5,000 Lbs.	Couplings Galvanized 2,500 to 5,000 Lbs.
¼	$54.23	$59.33	$11.36	$12.50	$4.82	$5.24
⅜	69.92	76.82	14.95	16.45	6.88	7.48
½	99.96	110.16	22.13	24.35	8.94	9.72
¾	135.24	149.04	29.16	31.86	12.55	13.57
1	161.70	178.20	38.88	42.48	15.50	16.76
1¼	217.56	239.76	71.28	77.88	20.66	22.34
1½	343.98	379.08	116.64	127.44	29.52	31.92
2	449.82	495.72	311.04	339.84	44.28	47.88
2½	568.56	623.76	686.88	750.48	59.04	63.84
3	695.42	760.82	793.80	867.30	73.80	79.80

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.
¼	250	$0.05½
⅜	250	.06
½	250	.09
¾	200	.12
¾	200	.15
¾	150	.18
1	100	.25
1¼	100	.33
1½	Odd lengths	.40
2	Odd lengths	55

1000 ft. and over.... 65%
Coils..... 55%
Less coils, 45%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.08	D. P. D. B.	$0.32
D. P. M. L.	.15	T. P. to D. P. S. B.	.18
T. P. M. L.	.23	T. P. S. B.	.29
D. P. S. B.	.17	T. P. D. B.	.47

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.40	$1 08	$1 35
T. P. M. L.	.57	1 50	1 95
D. P. S. B.	.51	1 35	.....
T. P. S. B.	.96	1 90	.....
D. P. D. B.	.72	2 45	.....
T. P. D. B.	1 58	4 40	.....
T. P. to D. P. D. B.	1.06	3 10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$12 50
No. 16 cotton twisted	15.75
No. 18 cotton parallel	14.50
No. 16 cotton parallel	18 00
No. 18 cotton reinforced heavy	20 50
No. 16 cotton reinforced heavy	24.00
No. 18 cotton reinforced light	18 75
No. 16 cotton reinforced light	22.00
No. 18 cotton Canvasite cord	15.00
No. 16 cotton Canvasite cord	17.75

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$0.25	3-amp. to 30-amp.,	100	$0.40
35-amp. to 60-amp.,	100	035	35-amp. to 60-amp.,	100	.60
65-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
110-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
225-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
425-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less 1-5th standard package, 50%; 1-5th to standard package, 55%; standard package, 65%.

RENEWABLE FUSES, ENCLOSED—

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50 ea.	$1.10 ea.	100	10
35 to 60-amp.	1.00 ea.	1.25 ea.	100	10
65 to 100-amp.	2.00 ea.	3.00 ea.	50	5
110 to 200-amp.	4.00 ea.	5.00 ea.	25	5
225 to 400-amp.	7.50 ea.	11.00 ea.	25	1
450 to 600-amp.	11.00 ea.	16.00 ea.	10	1
450 to 600-amp.	11.00 ea.	16.00 ea.	10	1

RENEWAL LINE FOR ABOVE FUSES—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:

Broken carton	5%
Unbroken carton but less than std. pkg.	22½%
Std. pkg.	40%

Discount Without Contract—Renewals:

Less than std. pkg.	Net list
Standard package	40%

Discount With Contract—Fuses:

Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%

Discount With Contract—Renewals:

Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$3 00
0-30 ampere, less than standard package	3.25

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.40	$0.45	100	75	$0.75	$0.80	50
15	.40	.45	100	100	1.10	1.20	24
25	.40	.45	100	150	1.55	1.65	24
40	.40	.45	100	200	2.10	2.25	24
50	.40	.45	100	300	3.15	3.35	24
60	.45	.50	100				12
				500	4.60	4.85	12
				750	6.50	6.85	8
				1,000	7.50	7.85	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.21
Composition 2-piece attachment plug	.28
Swivel attachment plug	.14
Current taps	.40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o b. New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$ 6.00	$ 7.80	$9.00	$14.50
12	8.00	10.20	11.95	19.20
10	10.95	12.75	15.20	24.68
8	14.25	16.60	19.50	32.91
6	.....	.....	29.35	.....
4	.....	.....	39.30	.....
2	.....	.....	55 00	.....
1	.....	.....	74.32	.....
0	.....	.....	93.00	.....
00	.....	.....	111.64	.....
000	.....	.....	133 72	.....
0000	.....	.....	159.52	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	Keyless Each	Pull Each	¾ In. Cap Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	15%
1-5th to standard package	30%
Standard package	45%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B. & S. regular spools (approx. 8 lb.)	33c. lb.
No. 18 B. & S. regular 1-lb. coils	34c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	32c. lb
Rubber tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	31c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	23c. lb
Soldering paste, 2 oz. cans	$1.50 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

30	70	1.06	1 60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.30	7.30
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10.00 list value	+5%
$10 to $25 list value	10%
$25 to $50 list value	15%
$50 to $200 list value	25%
$200 list value or over	30%